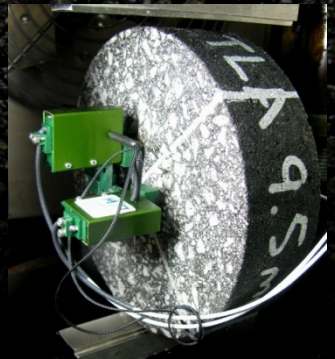
National Center for Asphalt Technology

NCAT

at AUBURN UNIVERSITY

Research Update

October 6, 2010



Overview

- About NCAT
- NCHRP Projects
- Current Research Focus Areas
  - Warm Mix Asphalt
  - Increasing RAP Contents
  - The NCAT Test Track
- NCAT Outreach

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NCAT History

- Established in 1986 through agreement with NAPA Research and Education Foundation and Auburn University
- The HMA industry raised $10,000,000 to establish an endowment fund for NCAT
- NCAT's mission is to provide technical leadership for the asphalt paving industry through research and outreach.

NCAT Staff

- 33 full-time employees
  - 7 Ph.D. research engineers
  - 8 assistant research engineers
  - technicians, accountants, drivers, and office support
- 10-15 engineering student employees
- Collaboration with AU faculty researchers in a wide range of academic disciplines

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NCAT Lead Researchers


Mr. Don Watson

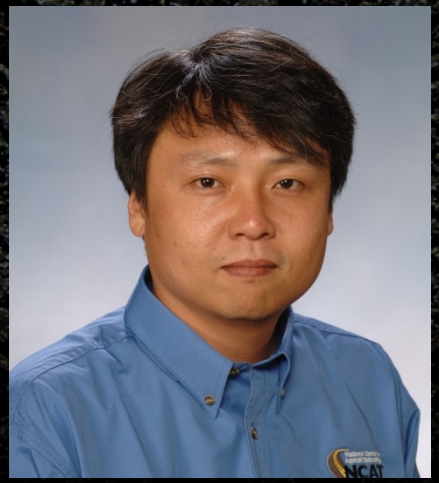

Dr. Buzz Powell


Dr. Mike Heitzman


Dr. Randy West


Dr. David Timm


Dr. Nam Tran


Dr. Jaeseung Kim


Dr. Richard Willis

NCAT Facilities

- 40,000 ft^2 Office and Lab
  - 22,000 ft^2 laboratory space
  - 18,000 ft^2 educational and office space
- NCAT Test Track
  - 1.7 mile oval track with 46 pavement test sections
  - Accelerated loading via 5 heavily loaded triple- trailers

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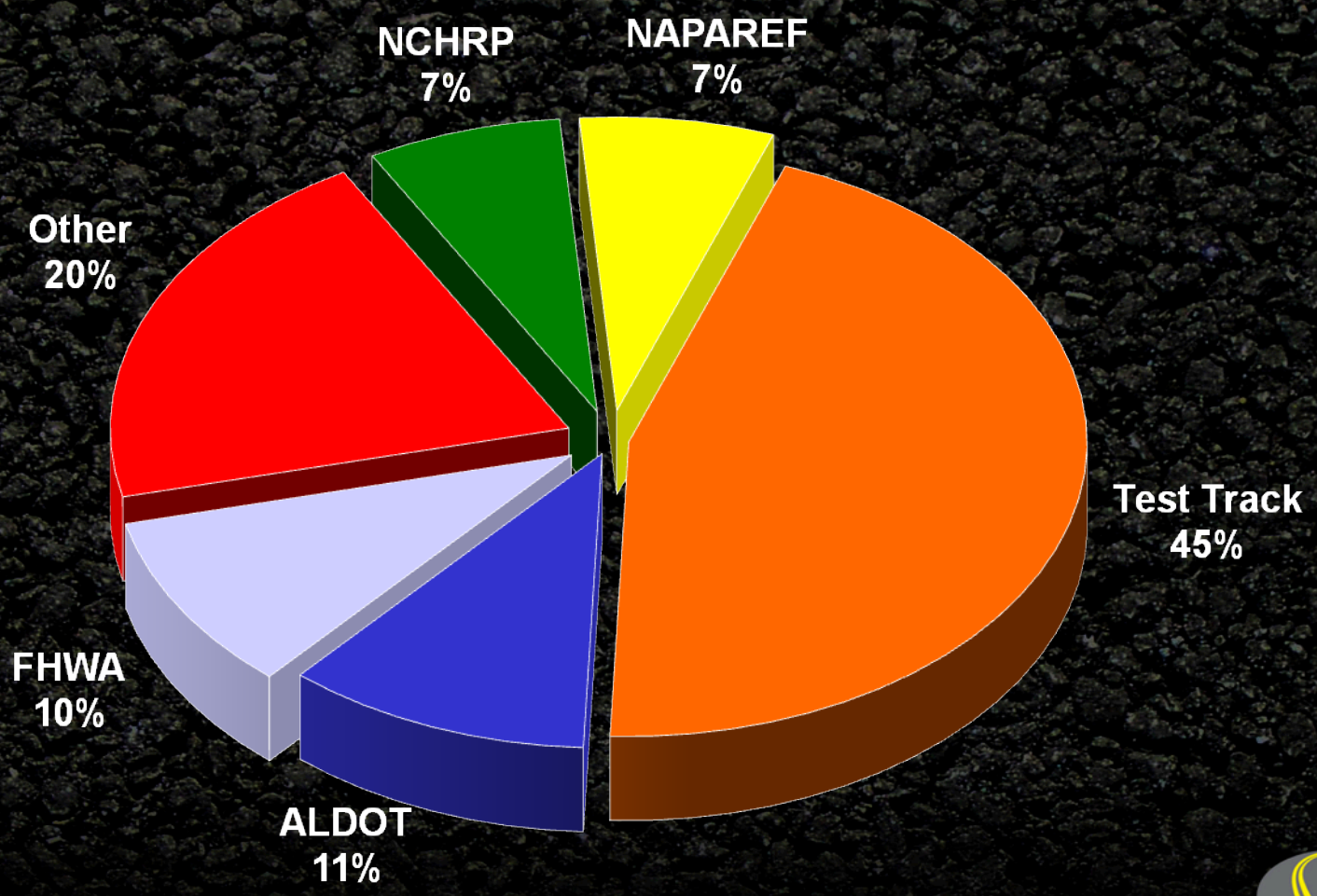
Funding Sources (FY10)



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NCHRP Projects

Recently Completed Projects

- Superpave Ndesign Table
  - NCHRP Report 573
- Validating the Endurance Limit for HMA
  - NCHRP Report 646
- Mixing & Compaction Temperatures
  - NCHRP Report 648

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NCHRP Projects

Ongoing Projects

- Improved Test Methods for Aggregate Specific Gravity and Absorption
- Improved Mix Design, Evaluation, and Materials Management Practices for HMA with High RAP Content
- Engineering Properties, Emissions, and Field Performance of WMA Technologies

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Warm Mix Asphalt

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Warm Mix Asphalt

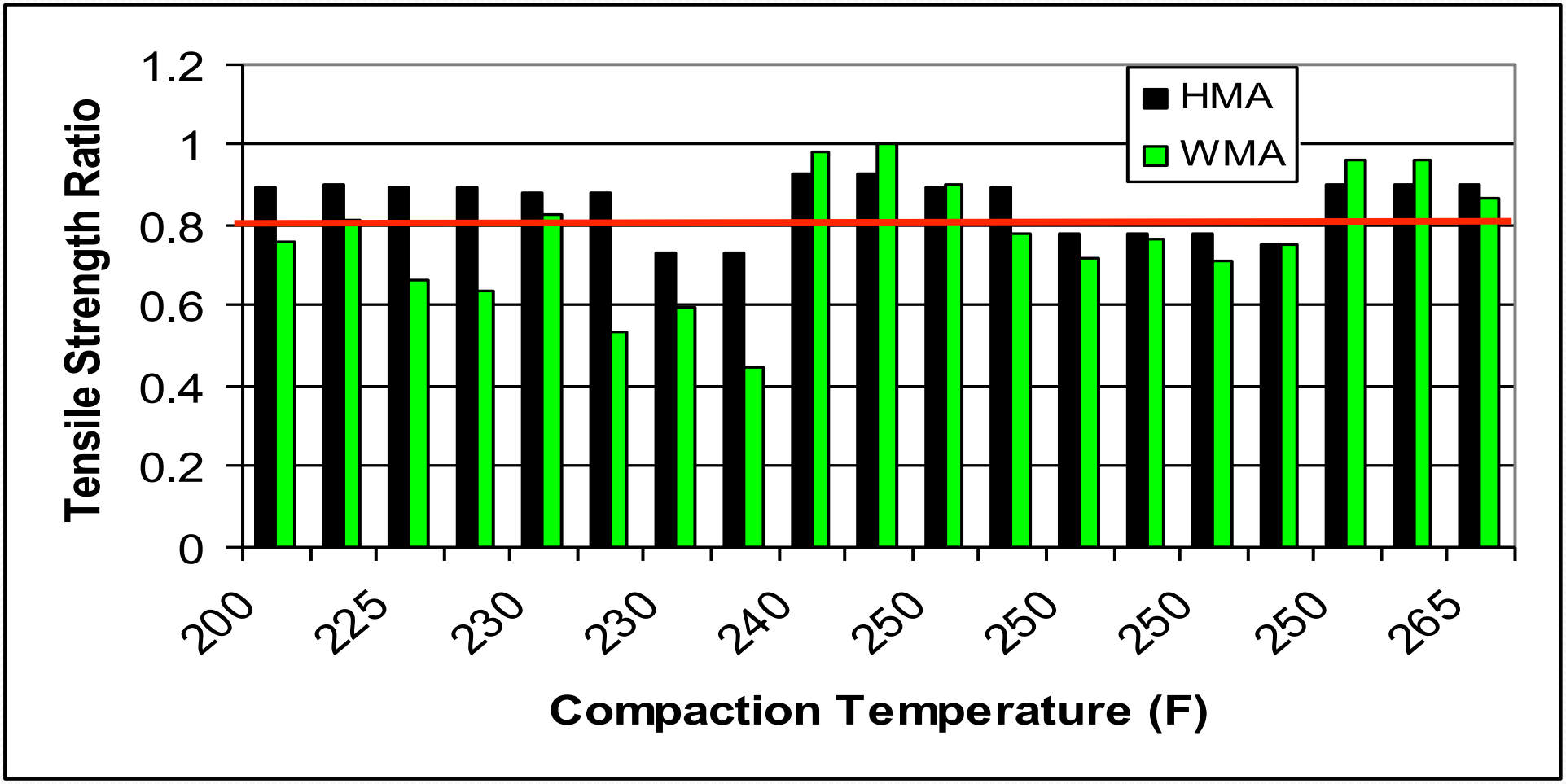
- WMA is asphalt mix produced with special technologies at temperatures 30 to 55°C lower than typical HMA
- Lower temperatures result in…
  - Less energy to produce asphalt mixes
  - Fewer emissions from asphalt plants
  - Less fumes and odors for paving crew and neighbors
  - Better workability at lower temperatures

NCHRP 9-47A Project Objectives

- Establish relationships between engineering properties of WMA to field performance
- Compare WMA to HMA
  - Performance
  - Construction practices
  - Emissions and fuel usage
  - Cost

NCHRP 9-47A Sites

Tensile Strength Ratio



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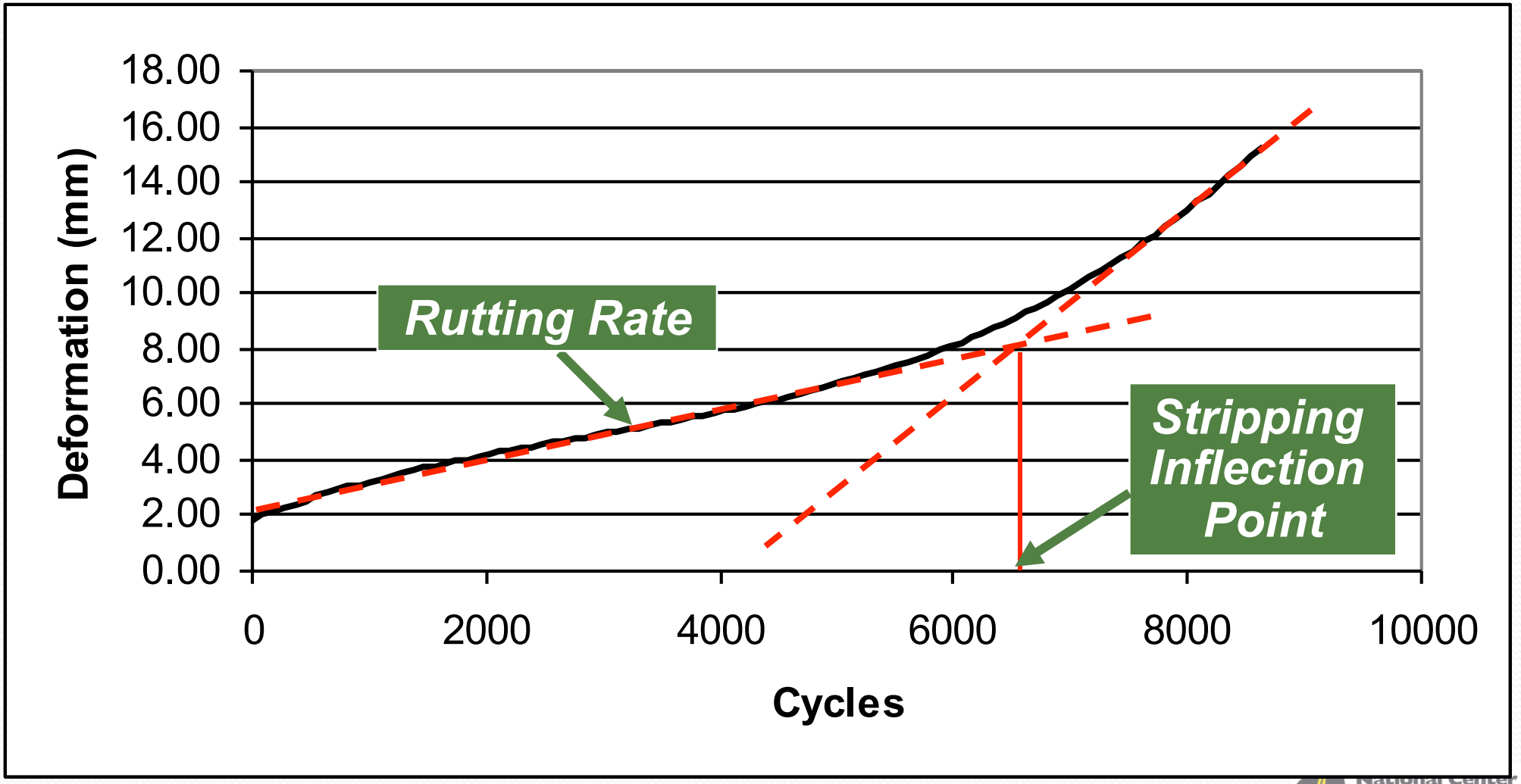
TSR Preliminary Analyses

- < 240°F: TSR of WMA is significantly different (less) than HMA
- > 240°F: TSR of WMA is not significantly different than HMA

Hamburg Testing

- AASHTO T 324
  - No additional aging of plant mix
  - Twin molds
  - 50°C water bath
  - 10,000 cycles or to failure
  - Stripping inflection point, rut depth, and rutting rate

Hamburg Analysis



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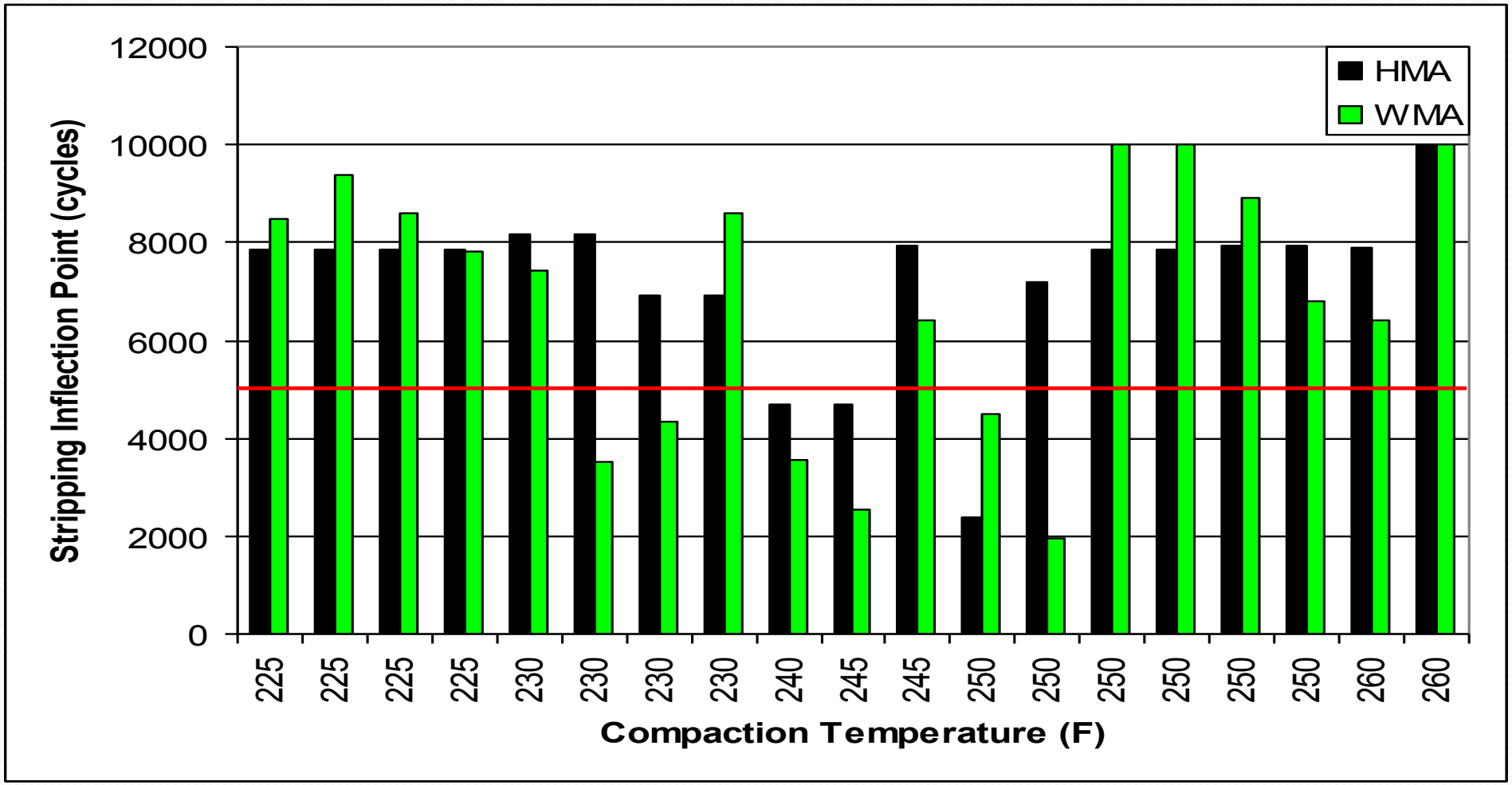
Hamburg : Stripping Inflection Point



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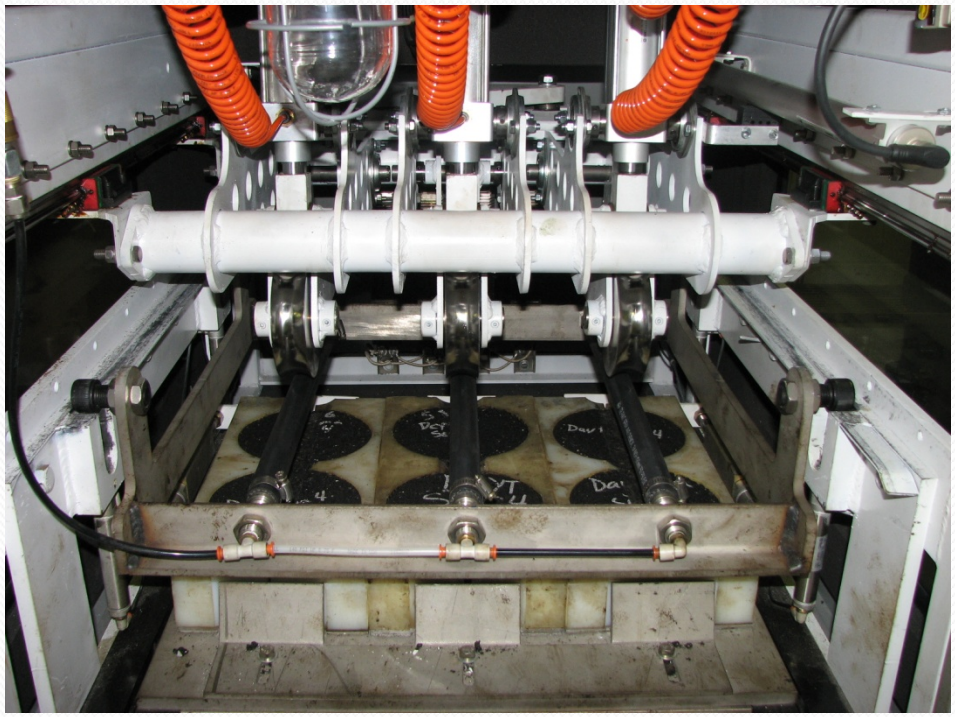
Hamburg Preliminary Analyses

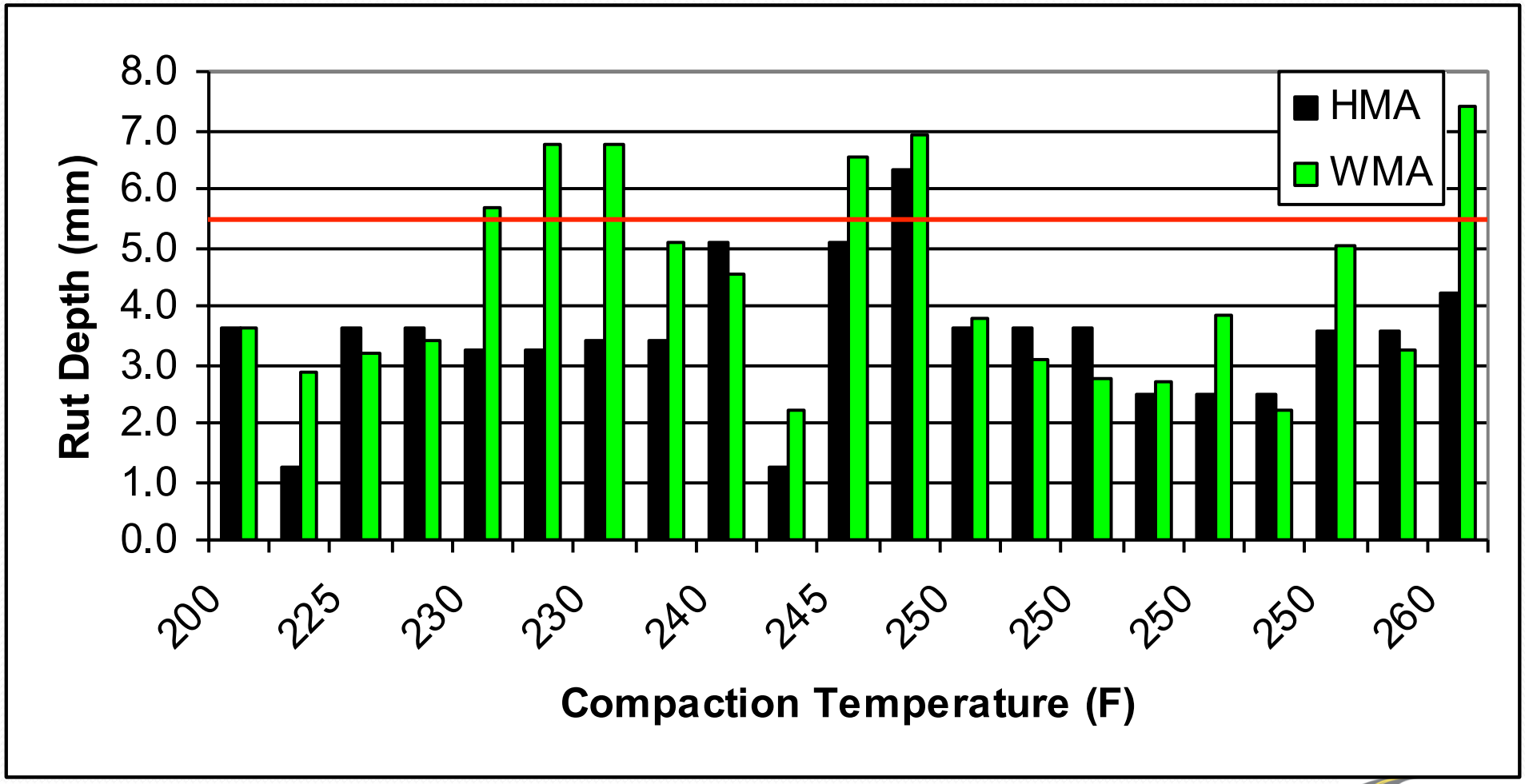
- Most WMA mixes meet Hamburg SIP criteria even though the test was not required for mix approval
- Differences between WMA and HMA are not statistically significant
- Compaction temperature does not have a statistical effect on Hamburg results

APA

- AASHTO TP 63
- 6 cylindrical specimens
- Specimens compacted to 7±1% air voids
- Tested at high PG
- Air chamber
- Rut depth (manual and automated)



APA Rut Depths



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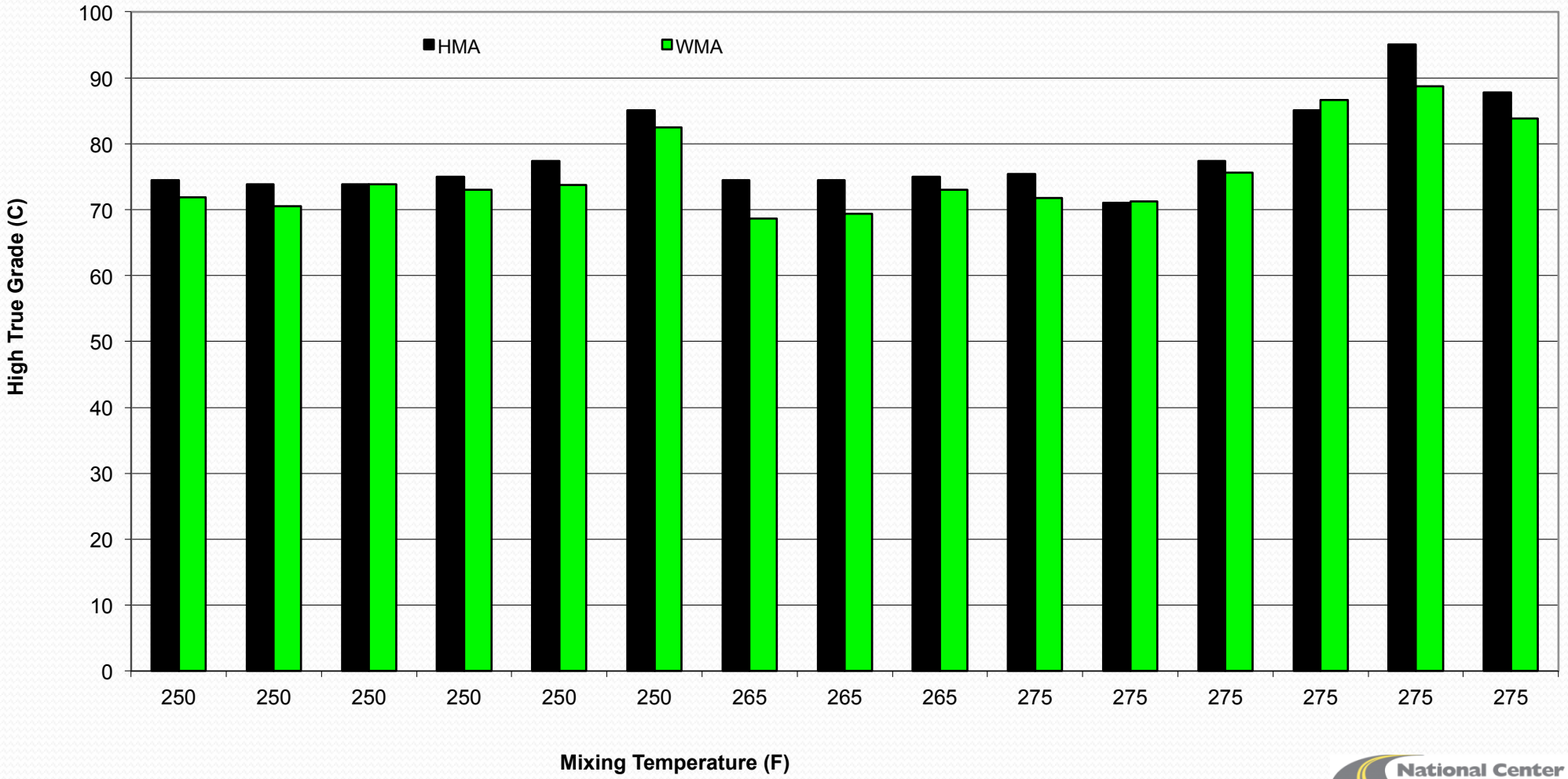
APA Preliminary Analyses

- Most WMA met a 5.5 mm rut depth criterion
- WMA often has a greater rut depth than the HMA
- < 240°F: WMA rut depths are significantly different (greater) than HMA rut depths
- > 240°F: Rut depths of WMA and HMA are not significantly different
- APA is known to be sensitive to binder stiffness

Recovered High PG



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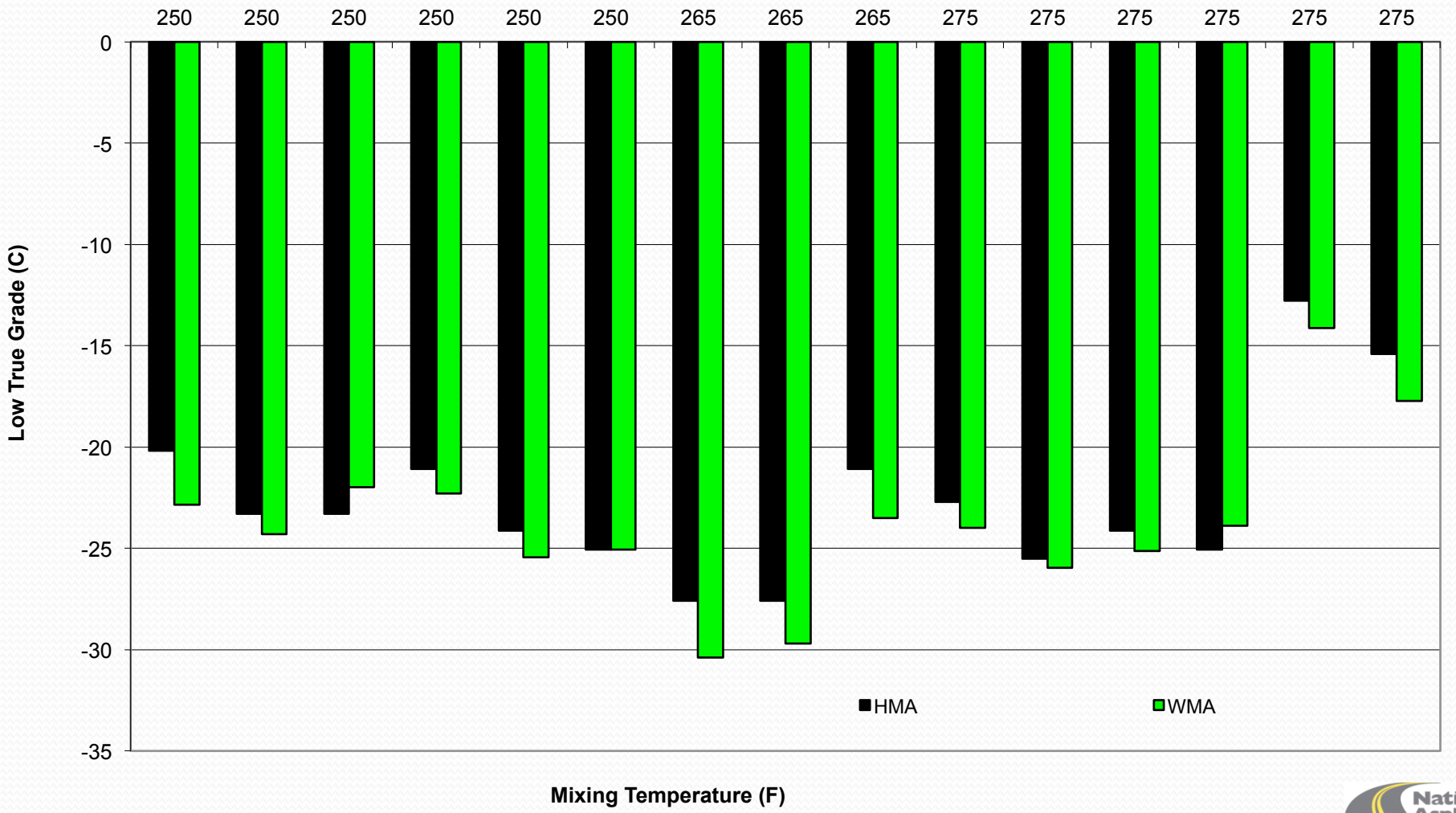
Recovered Low PG



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Increasing RAP Contents in Asphalt Mixtures

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Why Recycle Asphalt?

- Economic Payoff
- Pavement Benefits
- Natural Resource Conservation
- Energy Savings / Carbon Footprint

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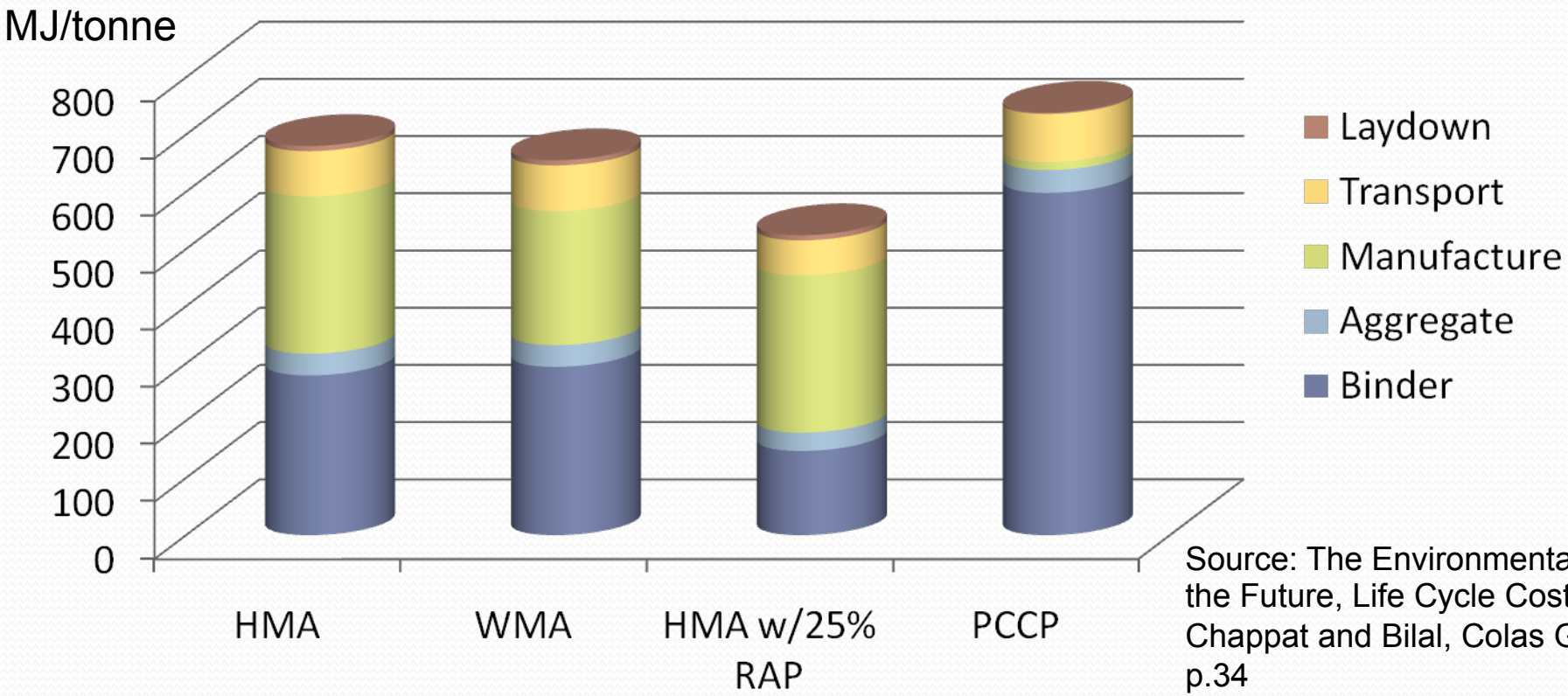
Energy Consumption Related to Road Construction and Maint.



Source: The Environmental Road of the Future, Life Cycle Cost Analysis, Chappat and Bilal, Colas Group 2003, p.34

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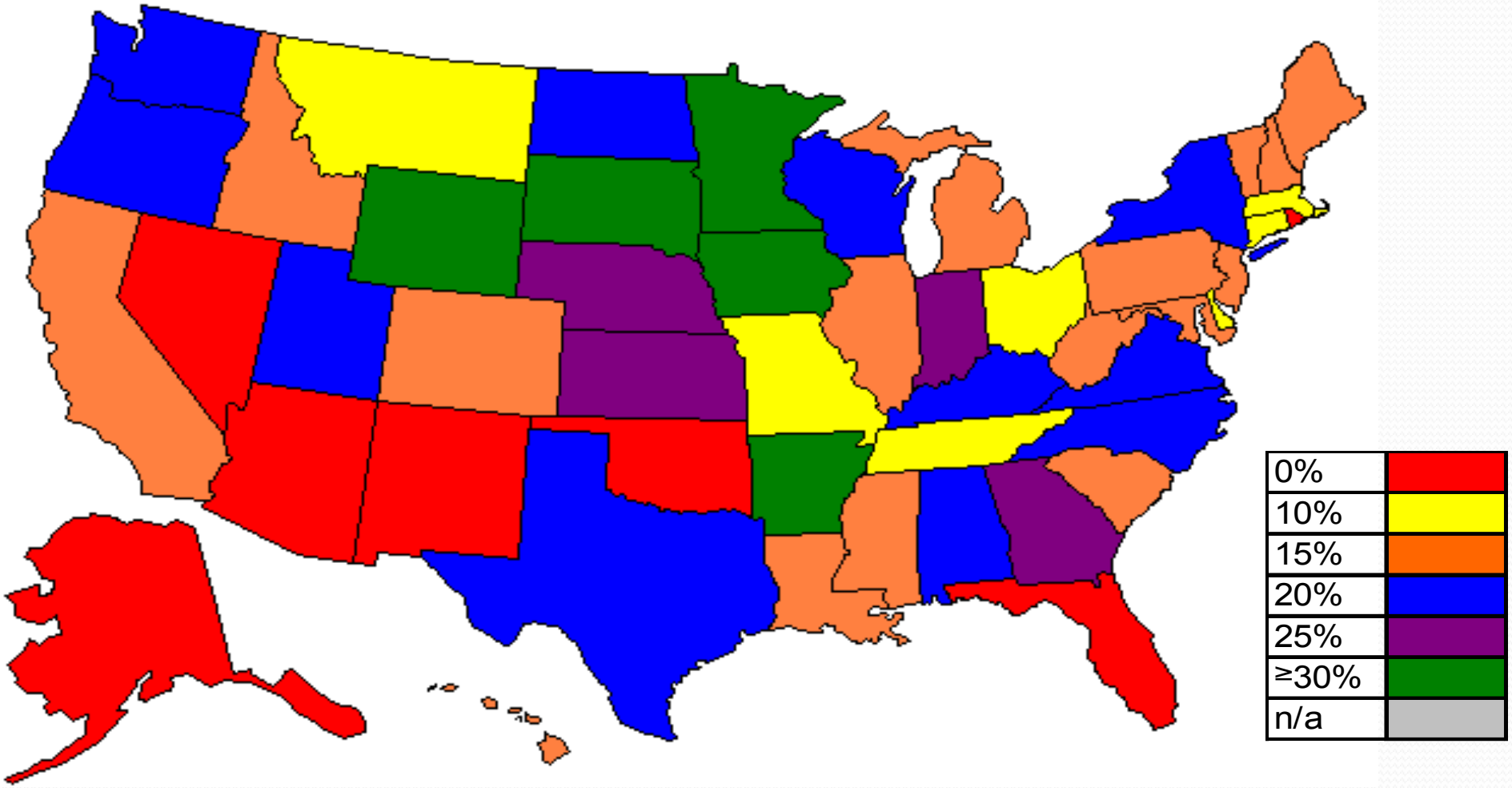
FHWA Recycling Expert Task Group

- Current state of practice for asphalt recycling
- Goal to increase average RAP content to 25% by 2013
- Identify barriers to effective RAP utilization
- Recommend research to address technical issues

Surface Mixes: % RAP Allowed



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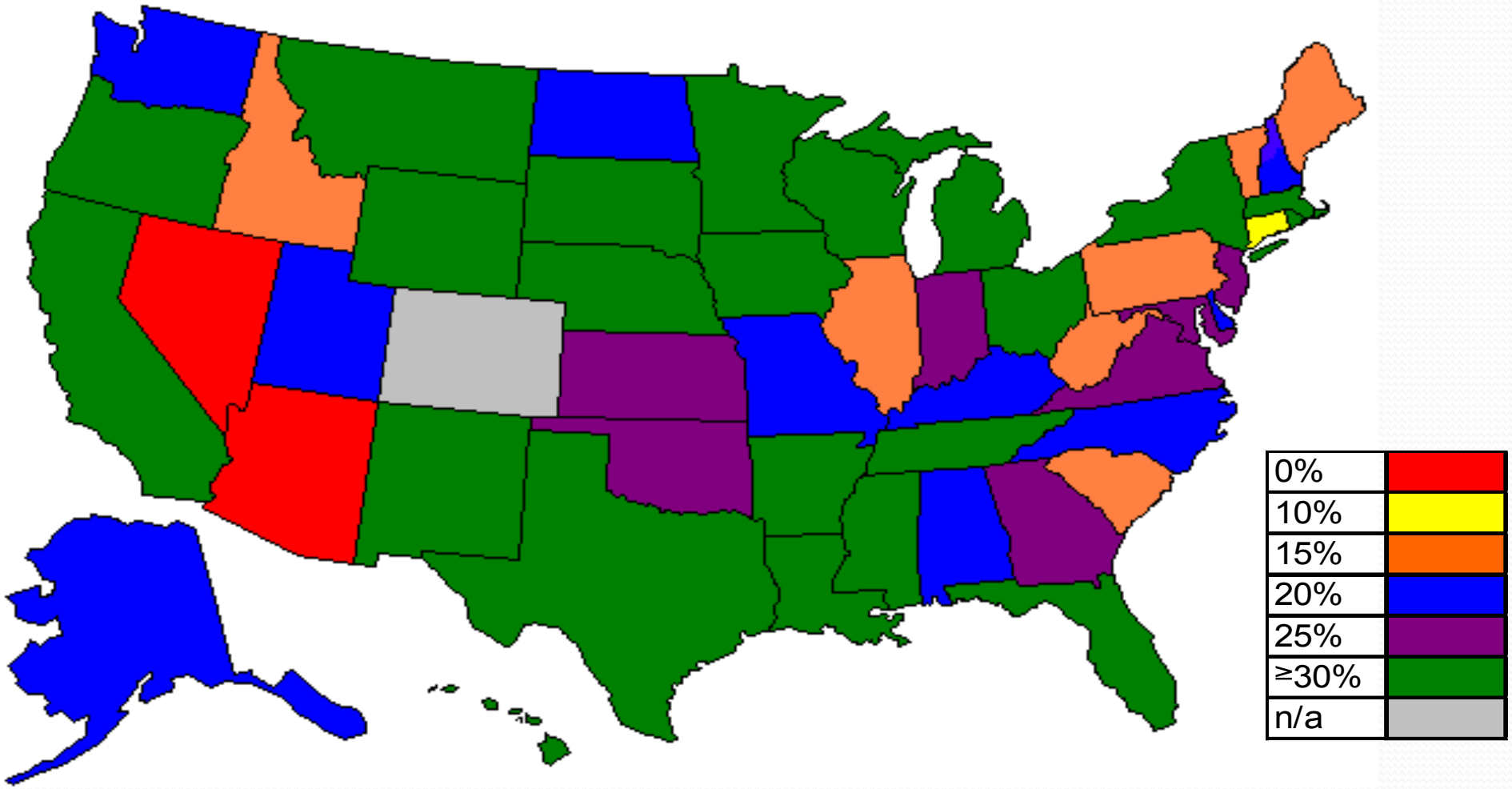
Base Mixes: % RAP Allowed



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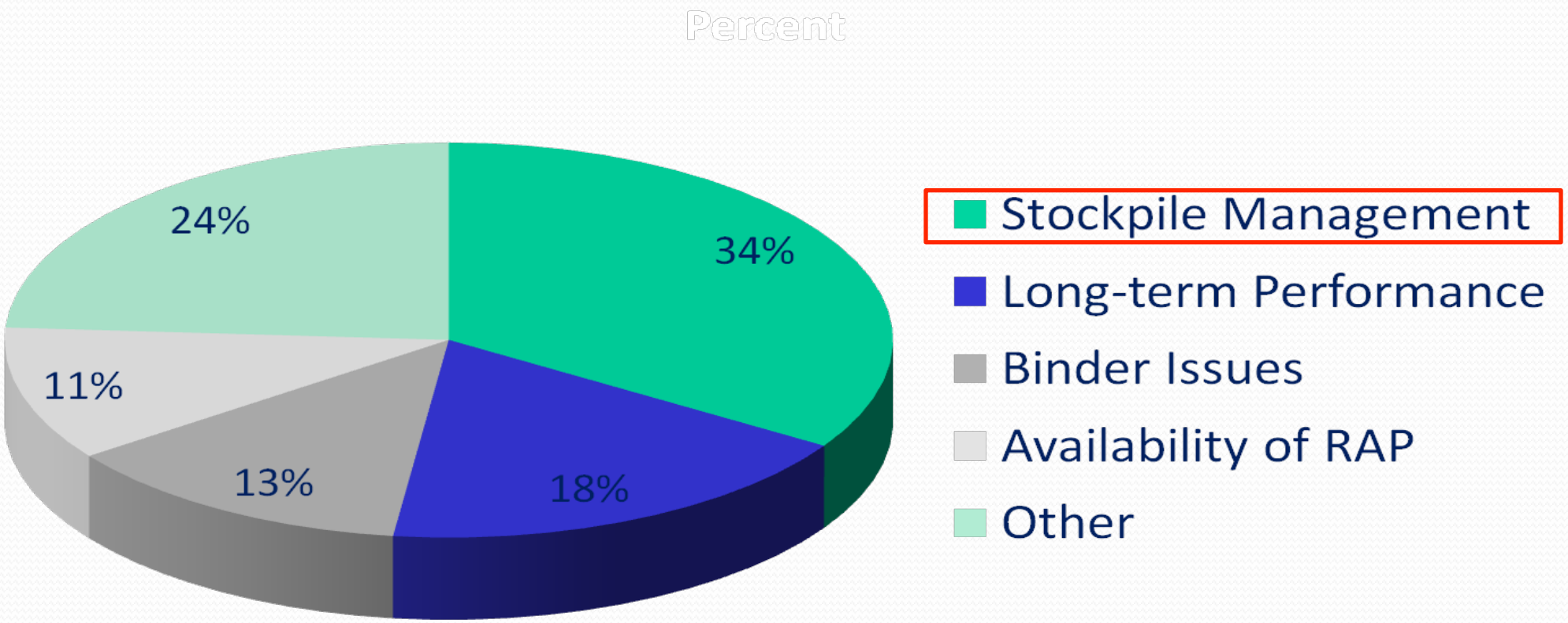
Barriers to Increasing RAP



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RAP Management Best Practices

- RAP Needs Analysis
- Milling for Success
- Multiple-source RAP piles
- Crushing Considerations
- Screening Options
- Best Practices for Stockpiling
- Sampling and Testing of RAP Stockpiles
- Production of Recycled Asphalt Mixes

RAP Sampling & Testing Flowchart

At least 10 samples when building stockpile

Split each sample

Ignition method tests

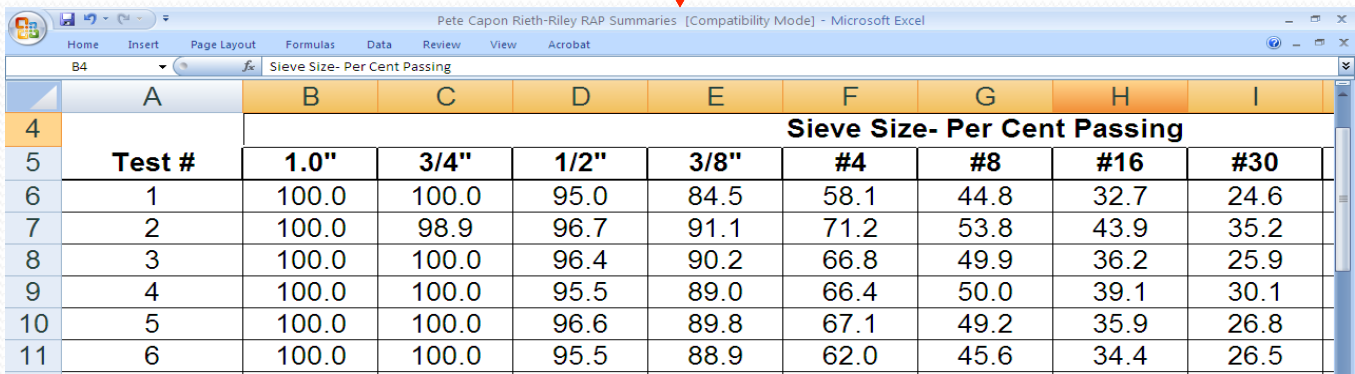
Max. specific gravities

Combine samples for other aggregate tests

gradations

asphalt contents

Gse → Gsb



Pete Capon Rieth-Riley RAP Summaries [Compatibility Mode] - Microsoft Excel

B4 Sieve Size- Per Cent Passing

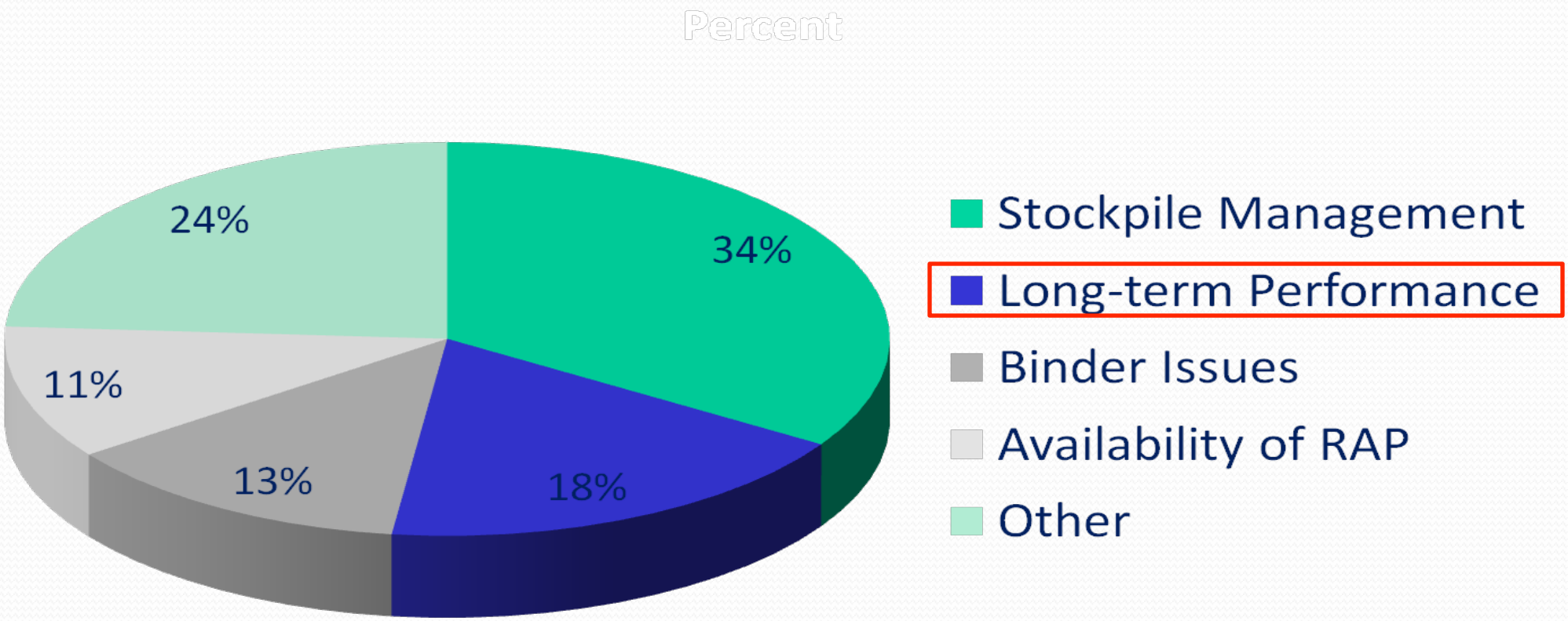
	A	B	C	D	E	F	G	H	I
4		Sieve Size- Per Cent Passing							
5	Test #	1.0"	3/4"	1/2"	3/8"	#4	#8	#16	#30
6	1	100.0	100.0	95.0	84.5	58.1	44.8	32.7	24.6
7	2	100.0	98.9	96.7	91.1	71.2	53.8	43.9	35.2
8	3	100.0	100.0	96.4	90.2	66.8	49.9	36.2	25.9
9	4	100.0	100.0	95.5	89.0	66.4	50.0	39.1	30.1
10	5	100.0	100.0	96.6	89.8	67.1	49.2	35.9	26.8
11	6	100.0	100.0	95.5	88.9	62.0	45.6	34.4	26.5

Summary & Analysis of RAP Data

- Calculate average and standard deviation of asphalt contents, gradations, and estimated Gsb
- Compare to the recommended tolerances

RAP property	Max. Standard Deviation (%)
Asphalt Content	0.5
% Passing Median Sieve	5.0
% Passing 75 micron Sieve	1.0

Barriers to Increasing RAP



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A Performance Comparison of RAP vs. Virgin Mixes

- LTPP SPS-5 pavement sections
- 18 U.S. states and Canadian provinces
- 500 ft. test sections
- Rehabilitated sections compare
  - 2" vs 5"overlay thickness
  - RAP (30%) vs virgin mixes
  - Milled vs unmilled surface preparation
- At least 30% RAP used in recycled mixes
- Projects range in age from 6 to 17 yrs

CONCLUSIONS

Based on the long-term performance of a large number of projects across North America…

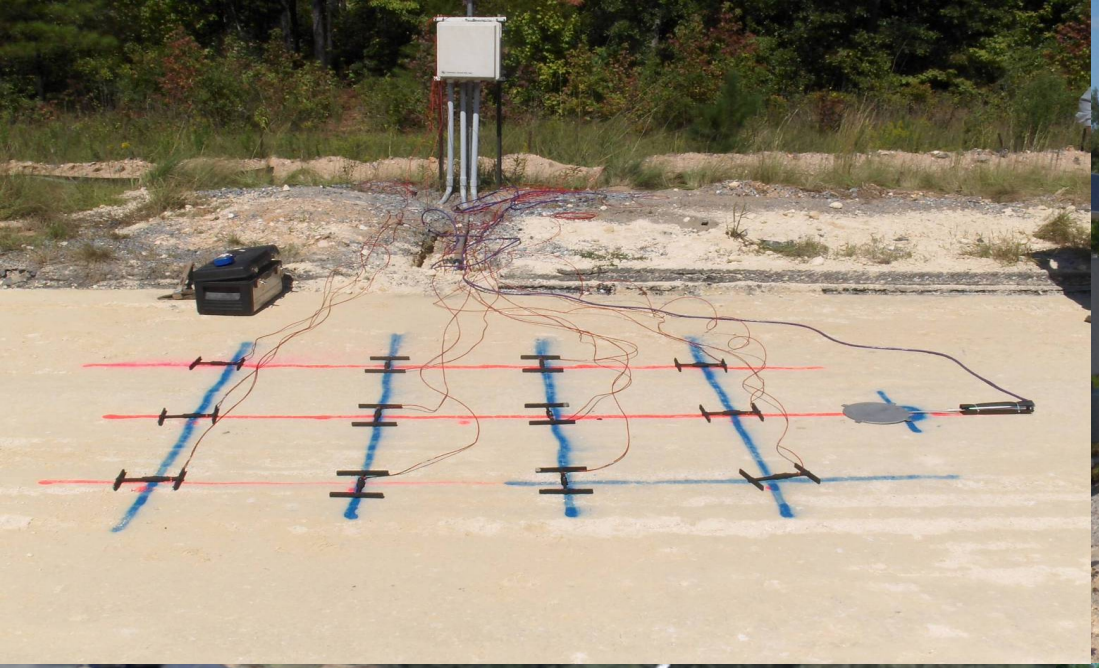
- Pavements using ≥ 30% RAP are performing well, and in most cases, perform equal to or better than virgin pavements
- Transverse and fatigue cracking were observed more often in some pavements with RAP compared to pavements with all virgin materials

Findings & Recommendations

- Differences in cracking performance for several locations may have been due to higher dust contents and/or lower asphalt contents
- Lessons learned that impact high RAP content mix designs:
  - We need to pay attention to mix characteristics that affect resistance to cracking. Simple effects like dust contents and binder content (through VMA).
  - It is not clear whether or not using a softer virgin binder has an affect on cracking performance.
  - We should include some type of a cracking test during high RAP mix designs.

NCAT Pavement Test Track

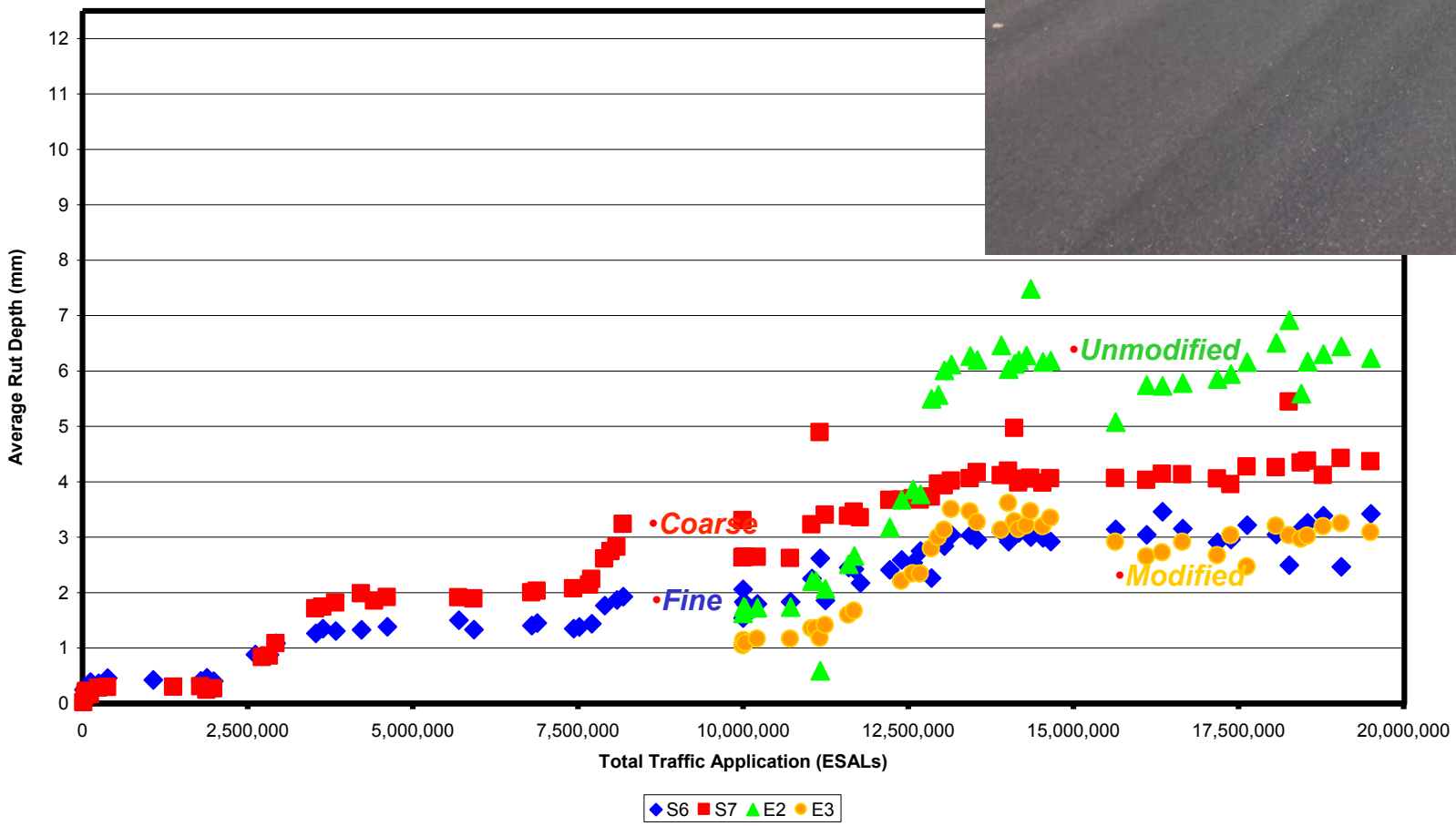
- 1.7 mile oval asphalt track
- 45 experimental test sections, each 200 ft. long
- Test sections are sponsored by highway agencies and businesses to evaluate specific materials and/or pavement design strategies
- Realistic traffic applies 10 million ESALs in each two year cycle
- Currently 50% complete with the 4th cycle




KNIGHT


NCAT
ARAN
ARAN
LASER SDP

Rutting Progression



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Big Pay Offs for Track Research

- Revised Layer Coefficient for Pavement Design
  - 18% reduction in thickness for new pavements
- Good Performance of High RAP sections
- Fine and Coarse Superpave mixes perform similarly
- Validation of Perpetual Pavement Design
  - Field Endurance Limit: 90th percentile strain of 250 $\mu\varepsilon$

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Test Track Research Findings

- Dense-graded mixes perform as well as SMA
- Modified binders reduce rutting around 50%
- Lowering N_{design} is O.K.
- Criteria for Lab Performance Tests
  - Air Voids
  - Asphalt Pavement Analyzer
  - Flow Number
  - Top-Down Cracking

Test Track Research Findings

- Aggregate specification assessments
  - Elimination of Restricted Zone
  - F&E requirements for SMA & OGFC
  - Higher LA abrasion aggregates in SMA & Superpave
  - Polishing prone aggregates disqualified for surfaces
  - Gravel performs well in SMA & OGFC
- Porous Friction Course (OGFC) benefits
  - Dual layer

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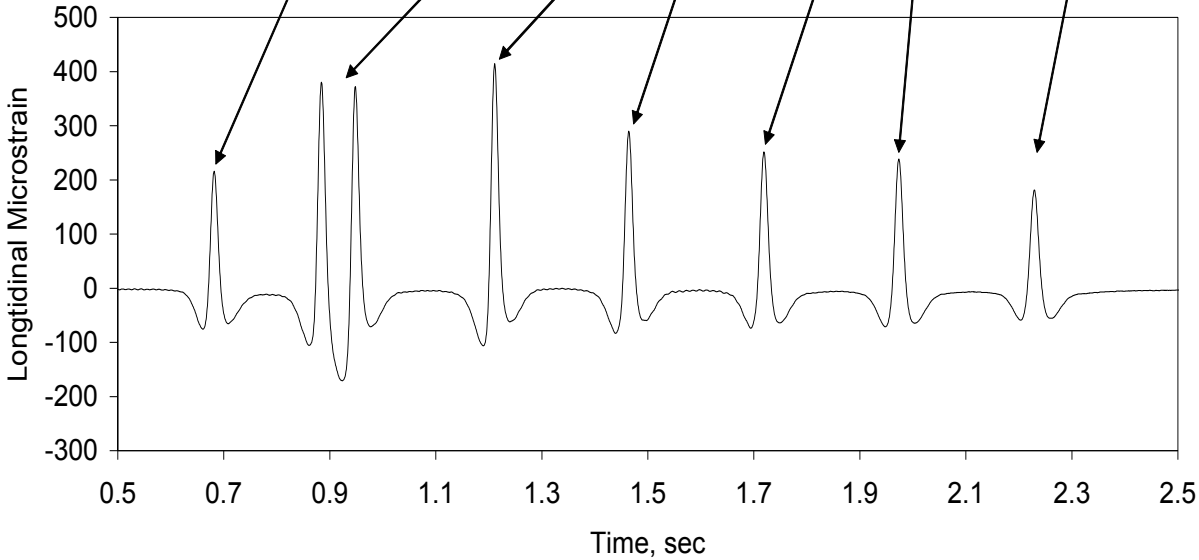
Test Track Research Findings

- Mechanistic pavement models validated and calibrated
  - Measured vs. predicted HMA tensile stresses
  - Compressive stresses in unbound layers
  - Pavement temperature models
  - Seasonal effects on pavement layers
  - Traffic wander
  - Transfer functions for strain damage
  - Speed vs strain / load pulse

Strain Instrumentation and Wireless Data Acquisition



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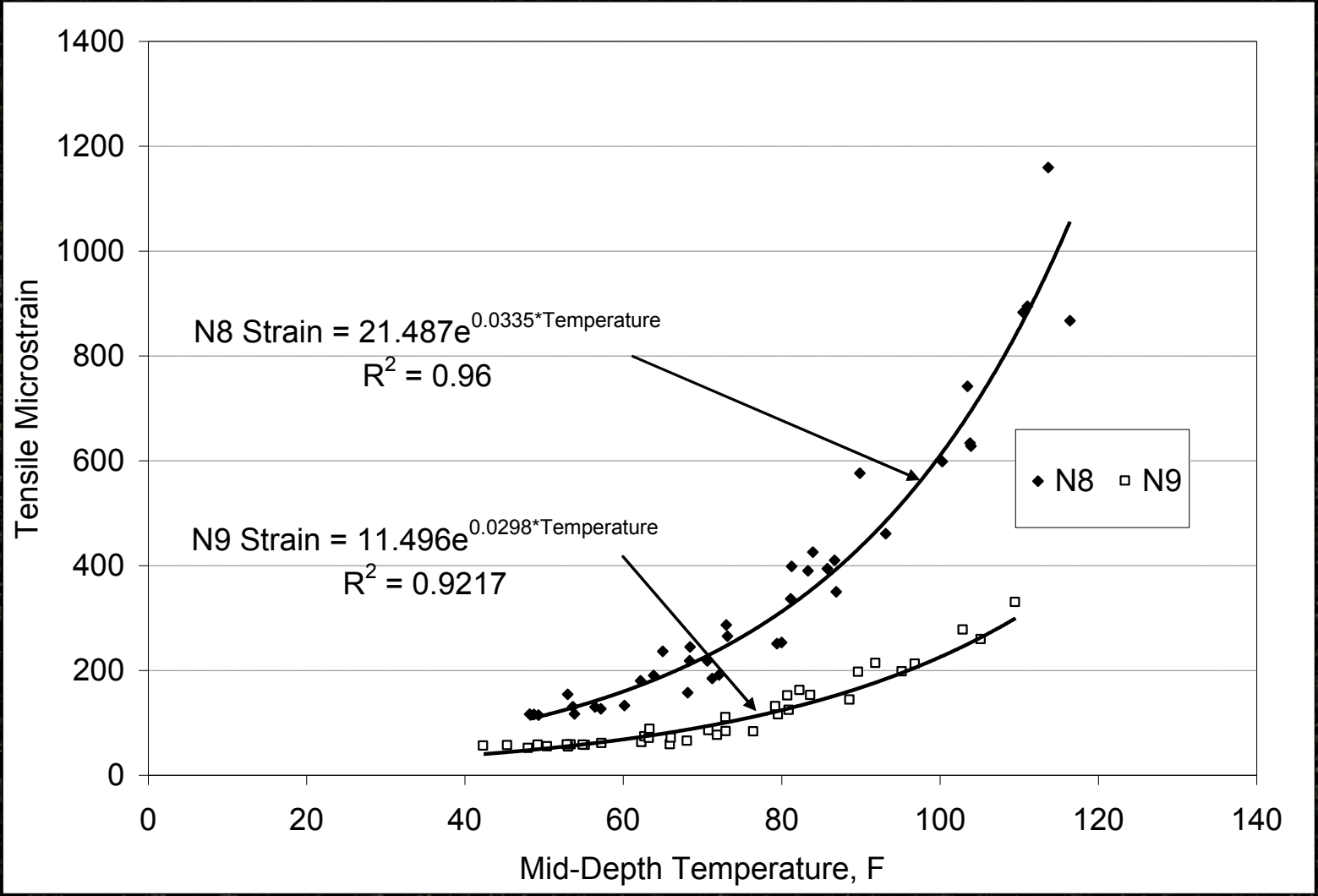
N8 and N9 – Strain vs. Temperature



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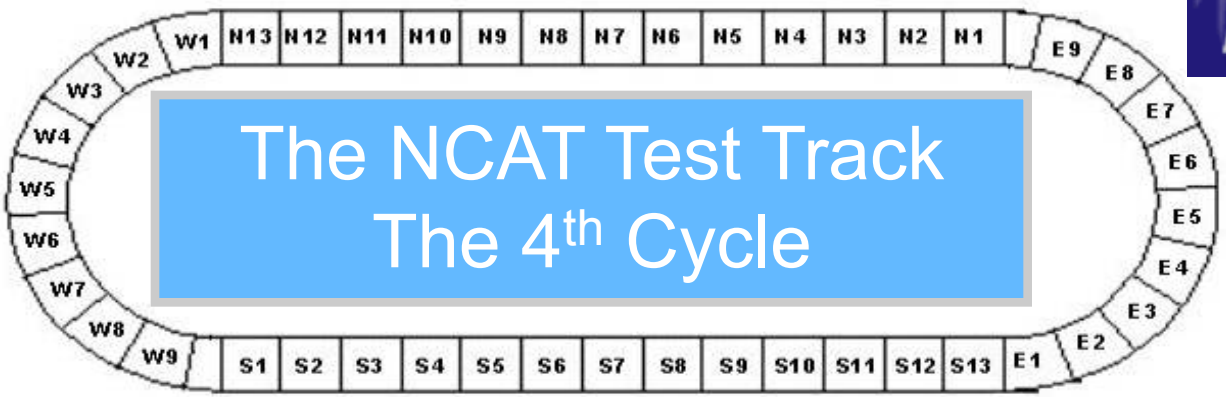
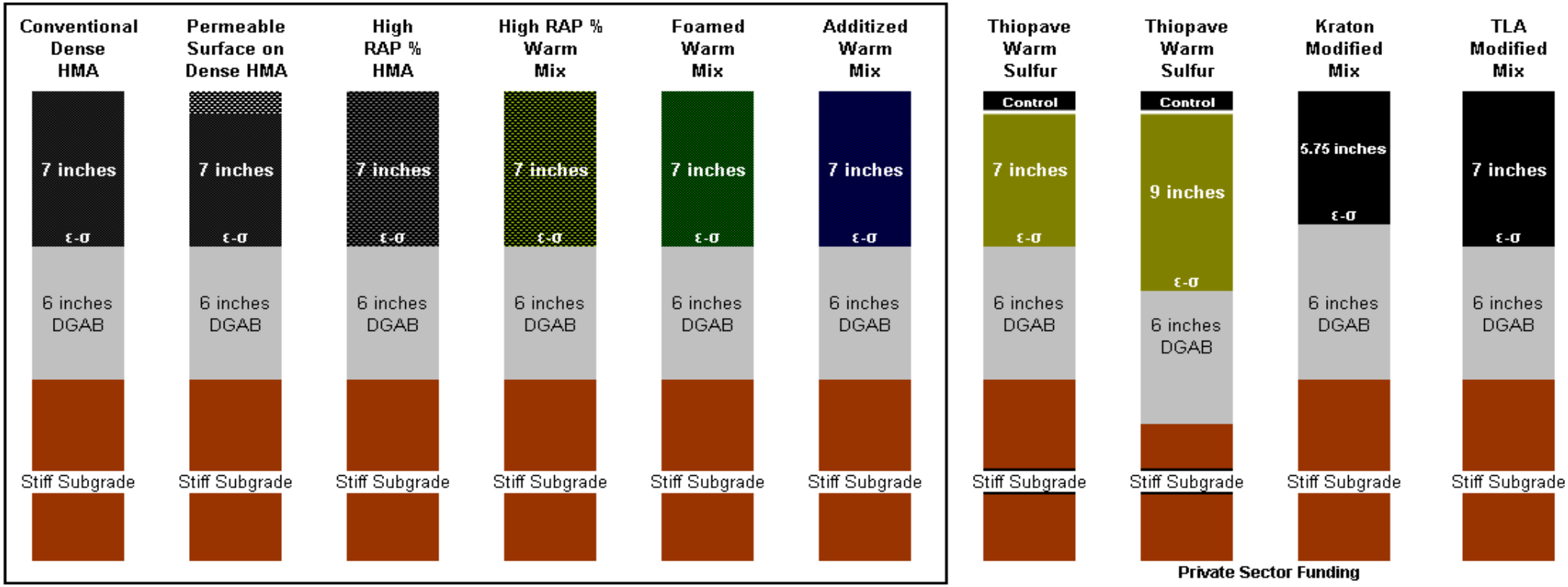
The NCAT Test Track
The 4th Cycle



Current WMA Research

- New full-depth NCAT Test Track sections
  - MeadWestvaco Evotherm DAT WMA
  - Astec Foamed Asphalt WMA
  - Control HMA
  - 50% RAP+WMA
  - Thiopave (Sulfur + WMA additive)

2009 Group Experiment



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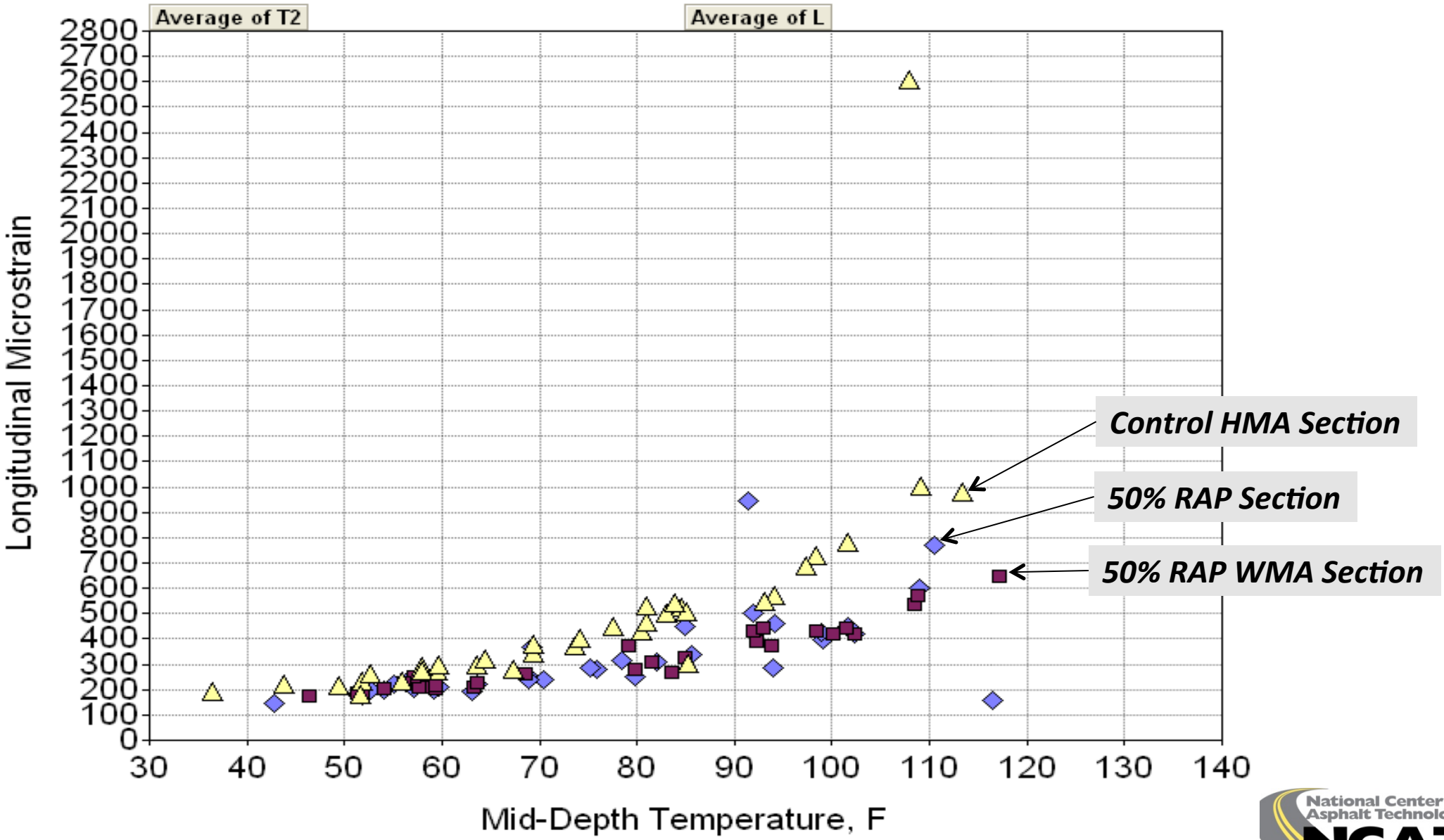
Group Experiment – High RAP (N10 & N11)



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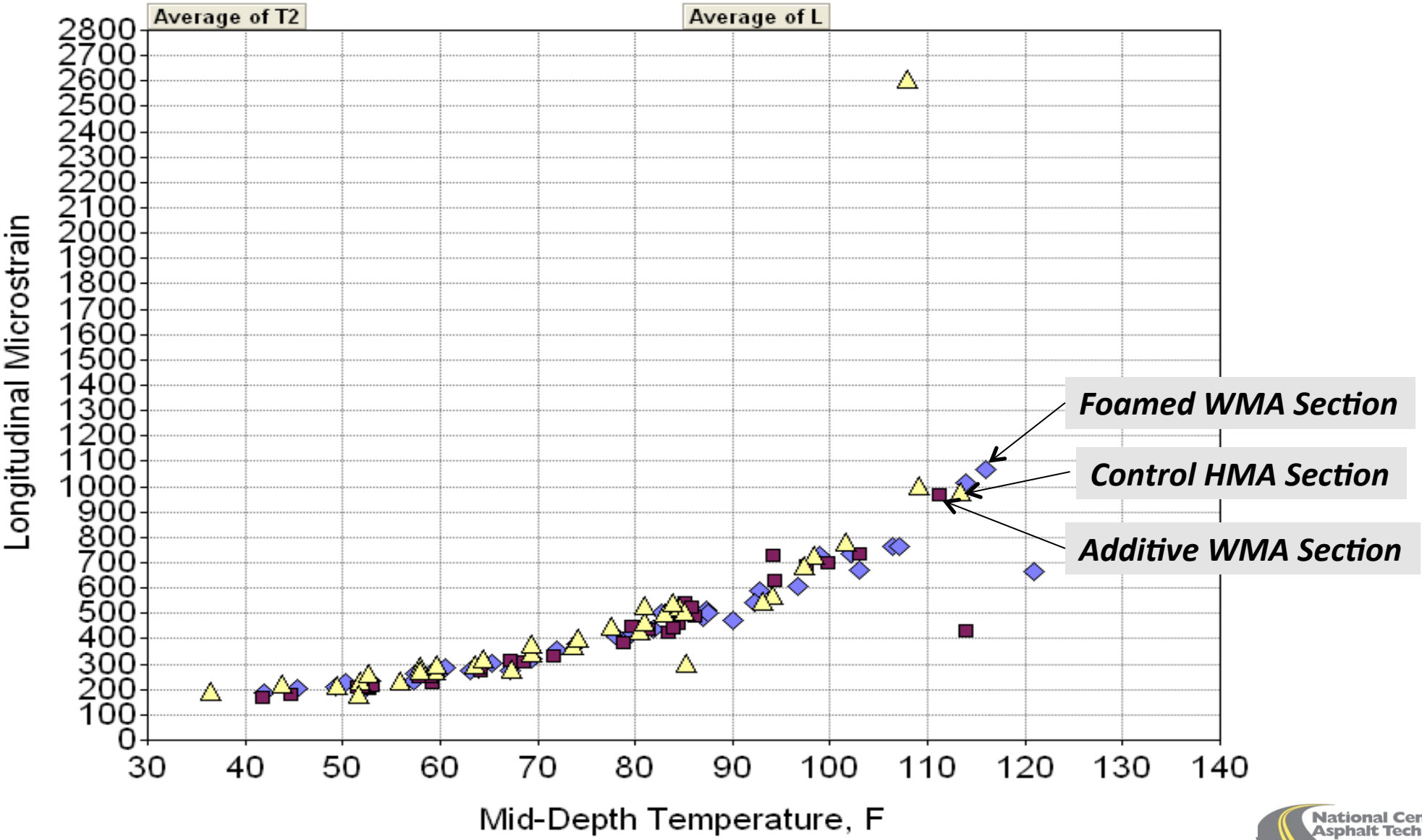
Group Experiment – Warm Mix (S10 & S11)



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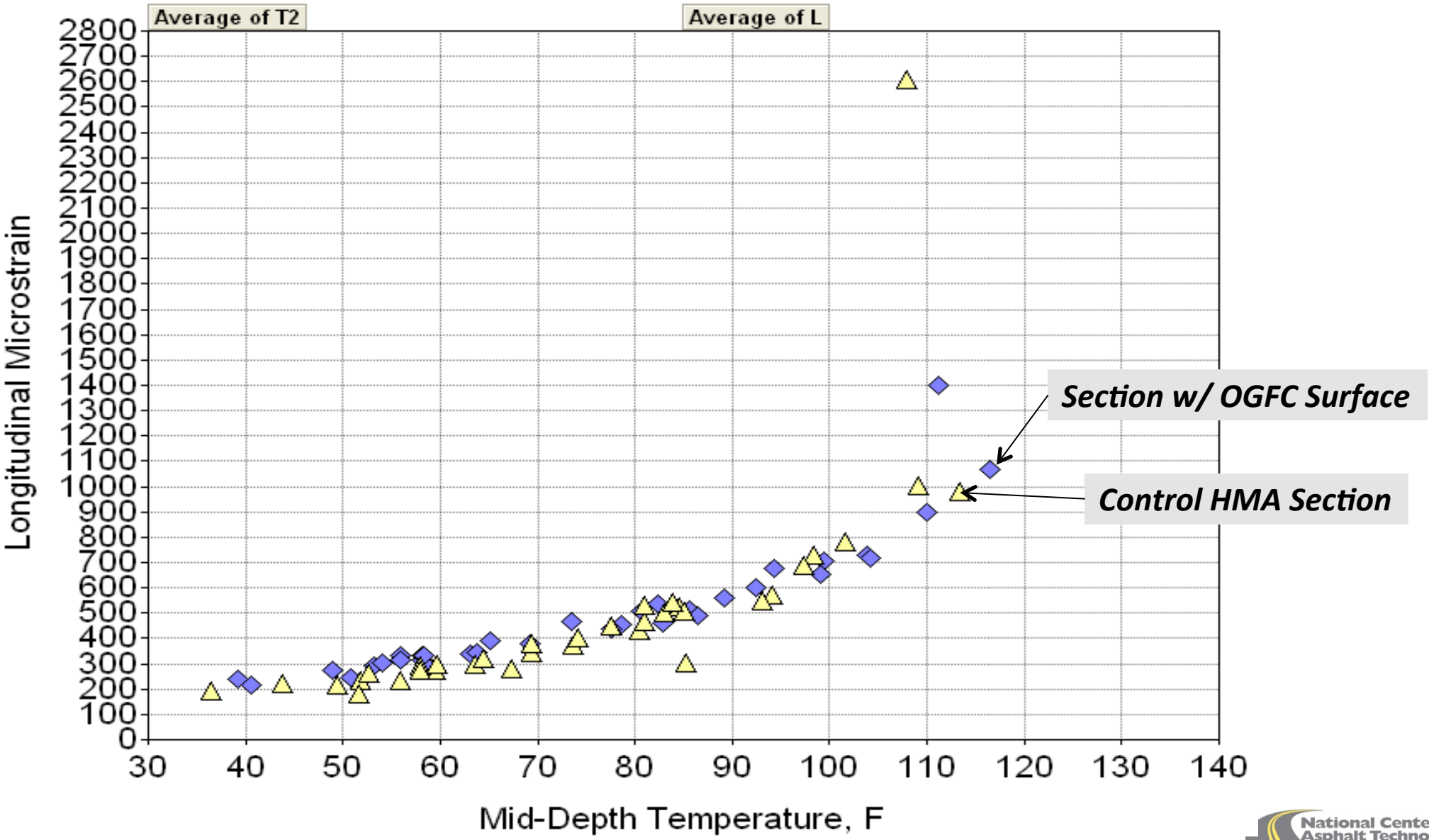
Group Experiment – OGFC (S8)



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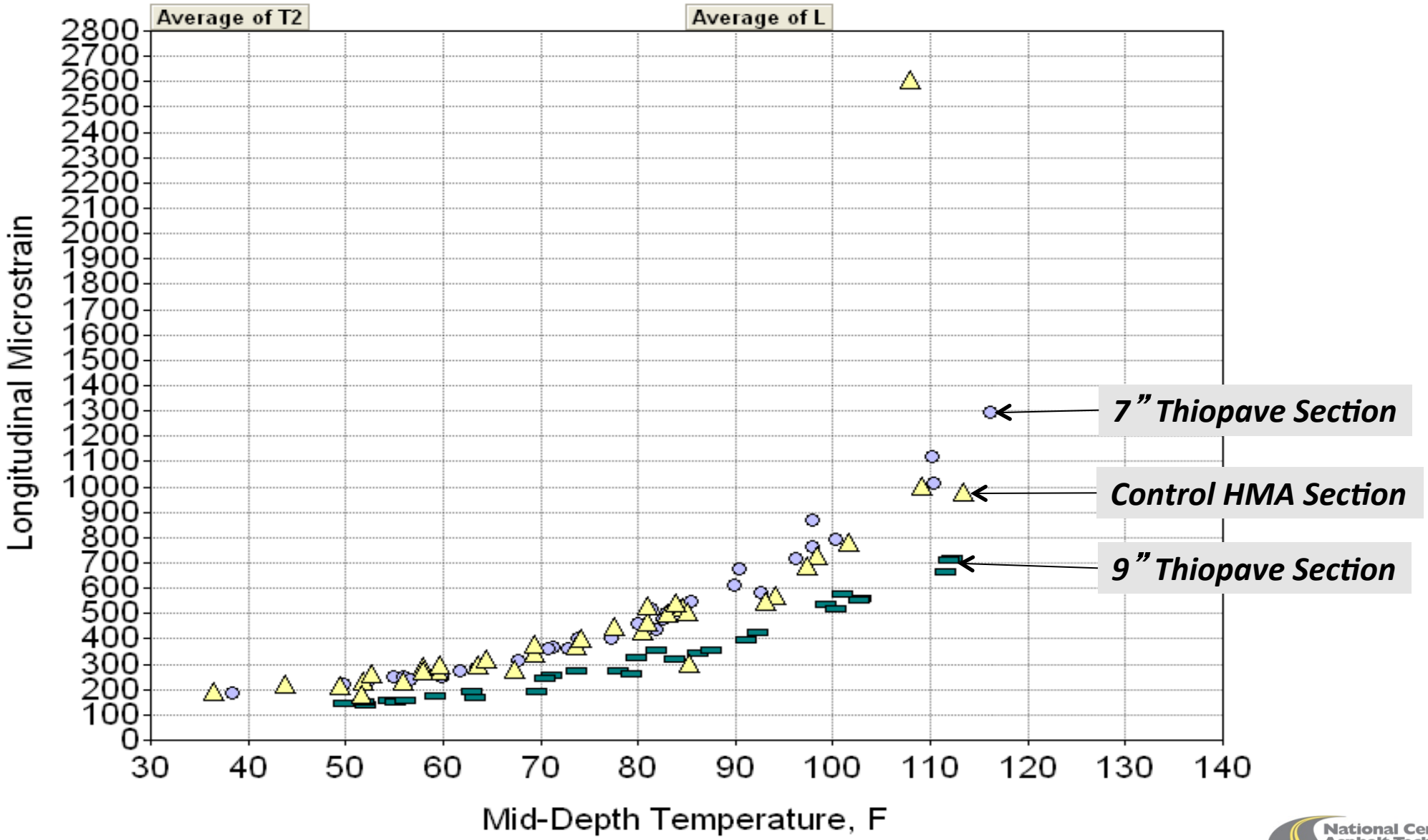
Thiopave® (N5 and N6)



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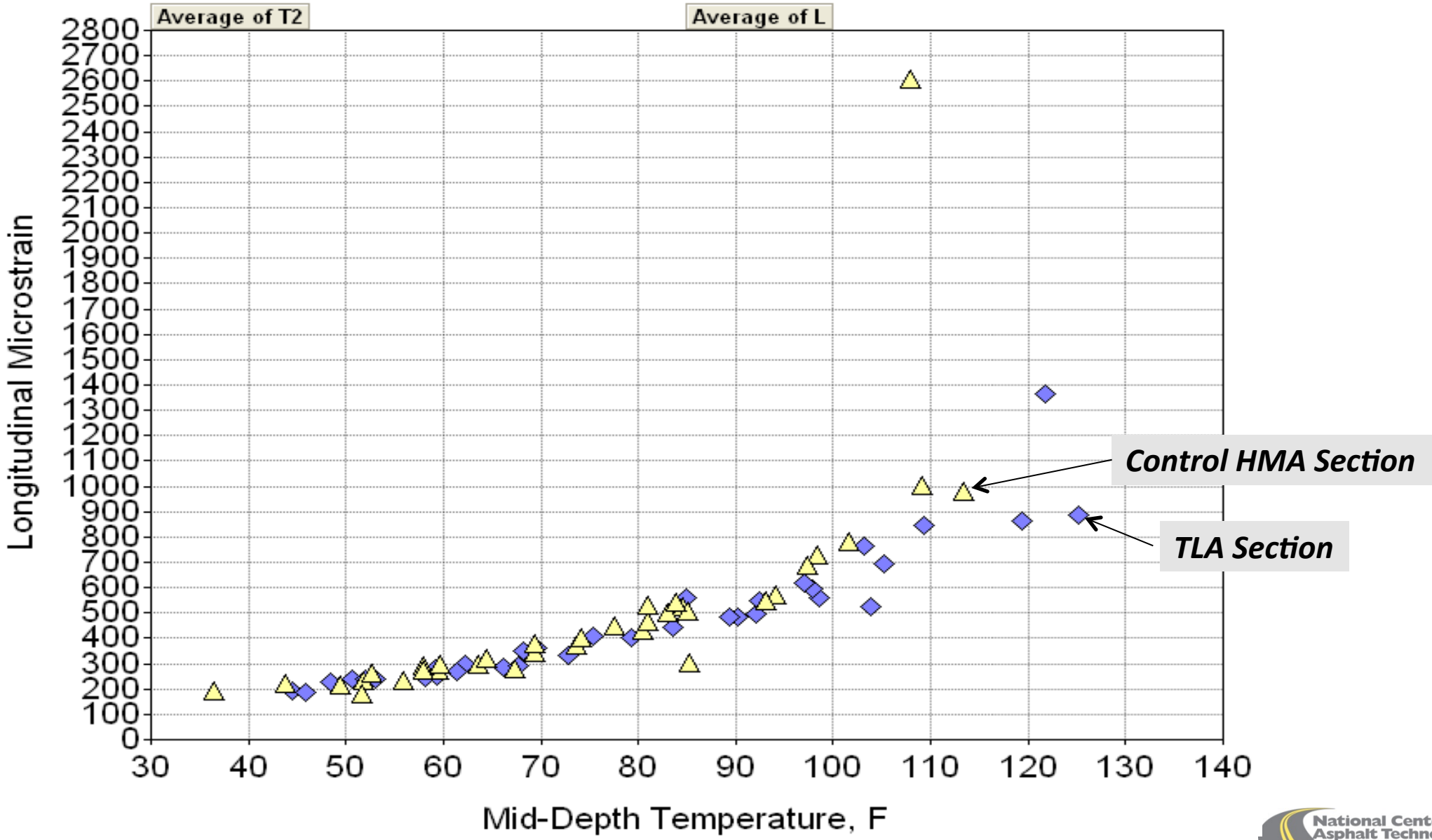
TLA – S12



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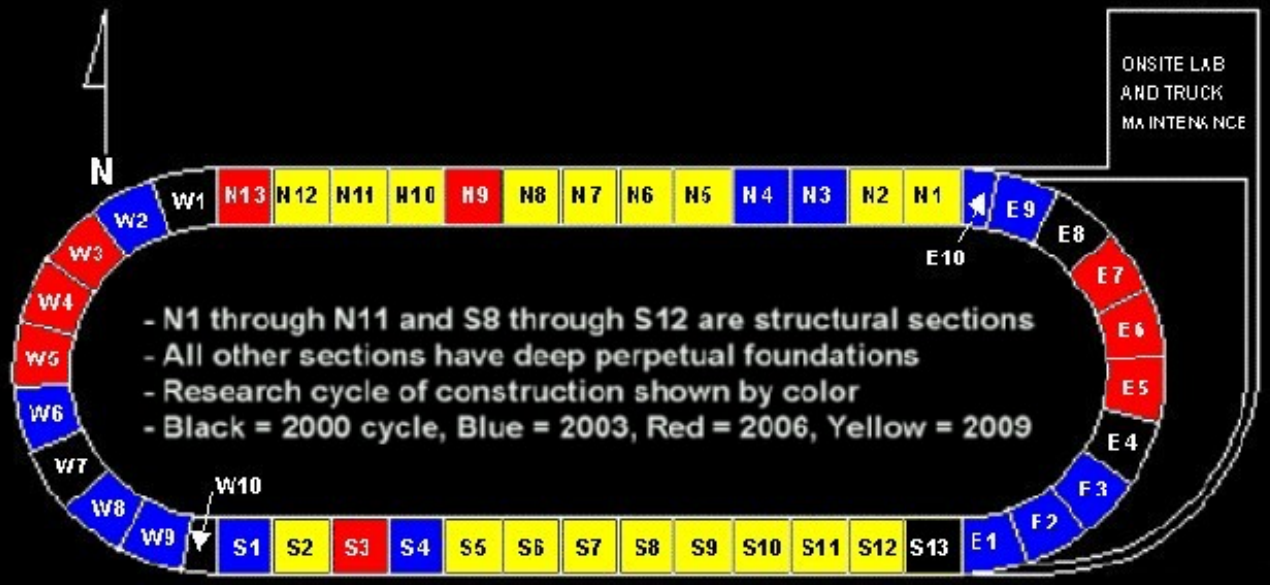
Click here for the official NCAT web site, Tracks in US, or Tracks Worldwide

- Construction data for each section can be viewed by positioning your mouse over the section in question and left-clicking. Be sure and page-down to see all the data for multi-layered sections. The entire buildup is shown in structural sections, but only the upper (research) mixes are shown in sections with perpetual foundations.



- Reconstruction of the 2009 experiment was completed in August of 2009 by East Alabama Paving, who was selected as the contractor via a competitive bidding process. The fourth research cycle again consists of extended traffic sections, new mix performance sections, and instrumented structural sections. The instrumented structural sections are part of a

NCAT Outreach

NCAT Outreach Components

- Communications
  - Website
  - Newsletter
  - Reports
  - Presentations
- Education & Training
  - Training courses
  - Courses for academic credit
  - Continuing education
  - Technology Transfer seminars
  - International Outreach

Our Outreach Goal is to better provide useful technical information that will help improve the life cycle cost of asphalt pavements.

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Thank You

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