National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

WMA & RAP
NCAT Update

AMAP 10th Annual Meeting - February 2009

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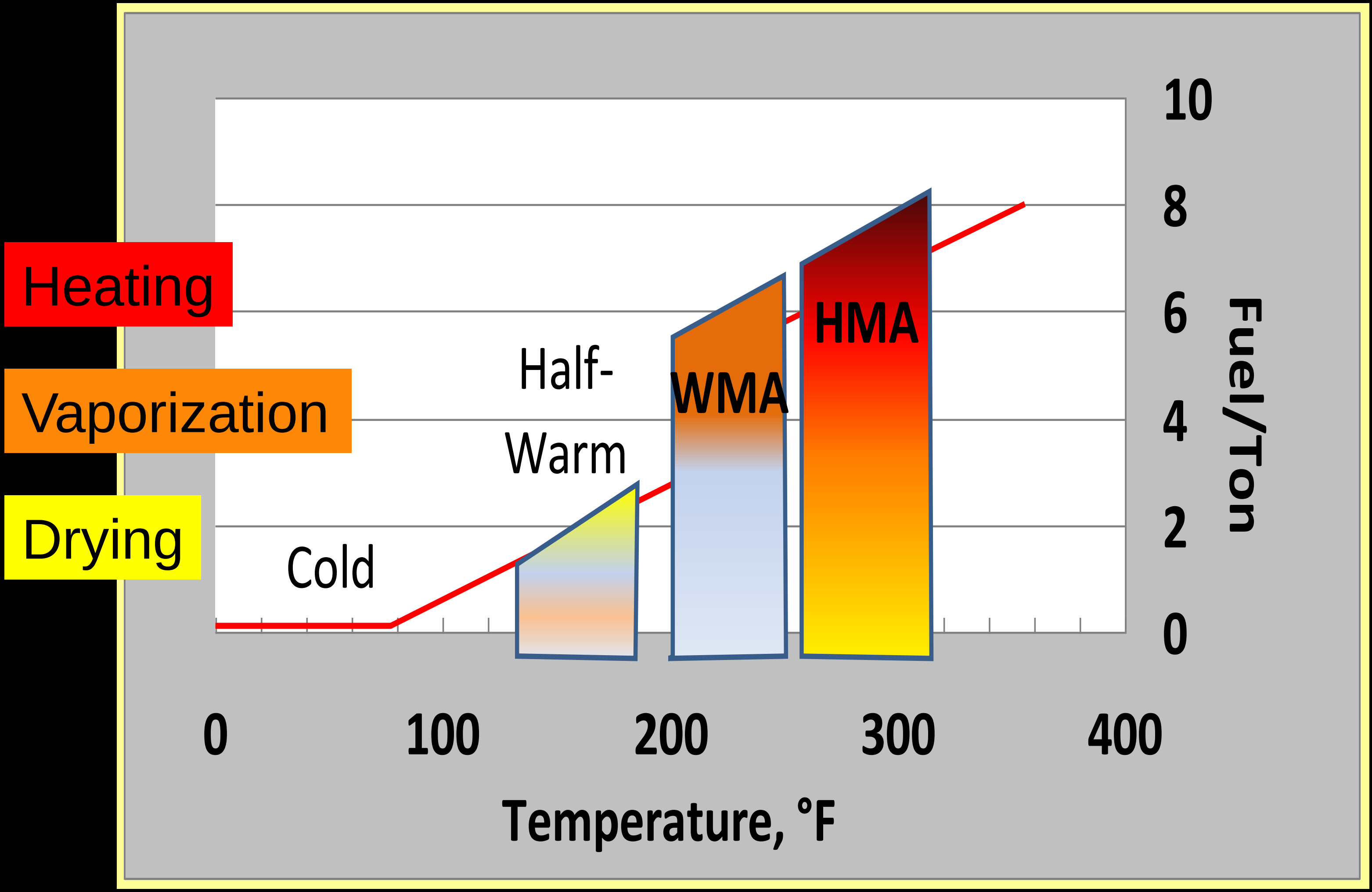
Assistant Director

Comparison of Asphalt Mixes



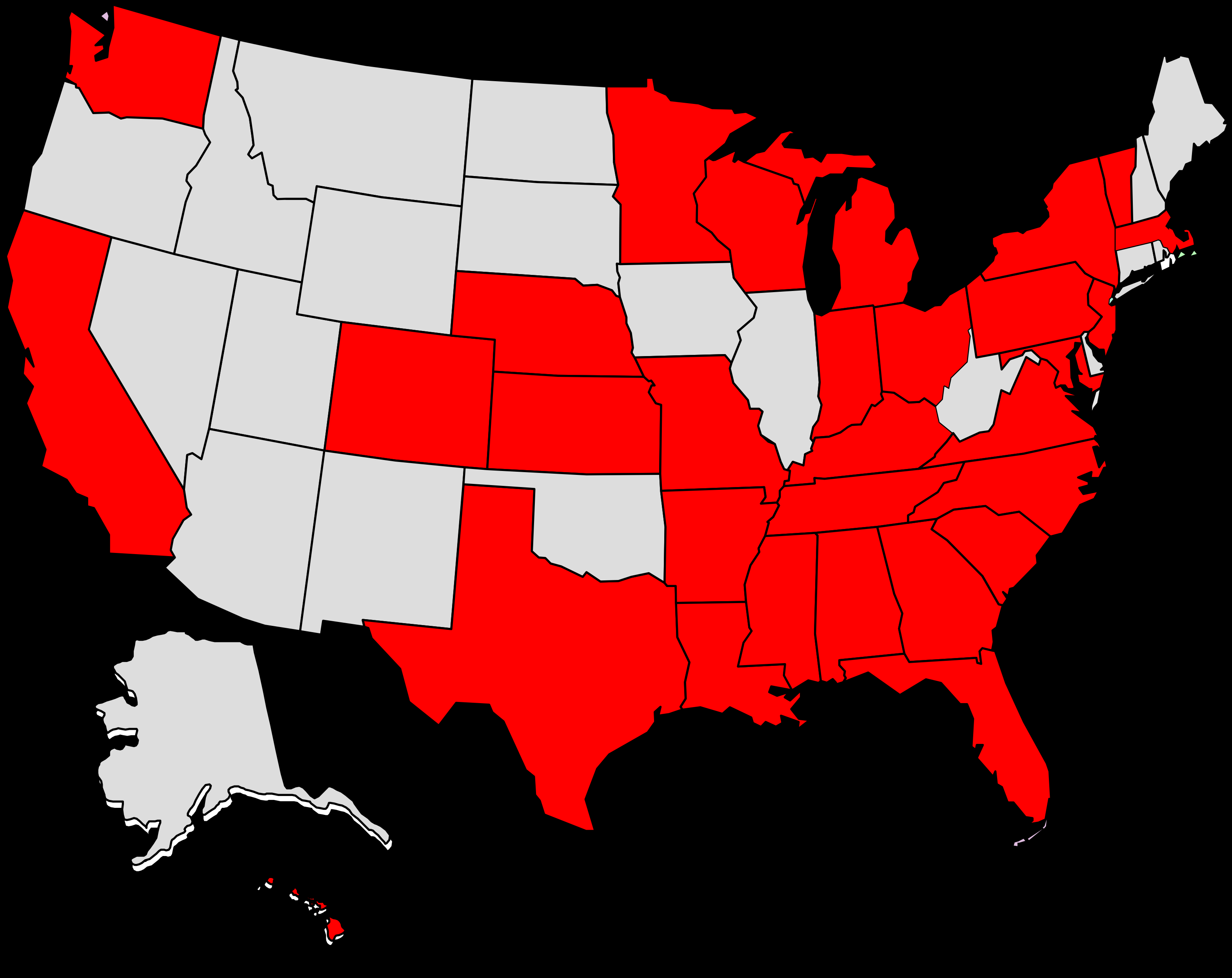
Why WMA?

- Reduce production and compaction temperatures
  - Extend paving season
  - Extend paving haul distance
  - Increase RAP percentage
- Reduce emissions

Why WMA? more…

- Reduce energy costs
- Reduce binder aging
- Reduce bumps from pre-existing crack sealant
- Compaction aid for stiff mixes
- Reduced odor

WMA Trials and Demo Projects



Are all WMAs the same?

- WMA encompasses multiple technologies

What are the Different Types of WMA?

- Wax-like additives
- Mineral additives
- Emulsion based
- Foaming
- Chemical additives

How Do You Design a WMA?

- HMA mix designs with WMA technology dropped in
- WMA air voids sometimes look lower in lab compacted specimens

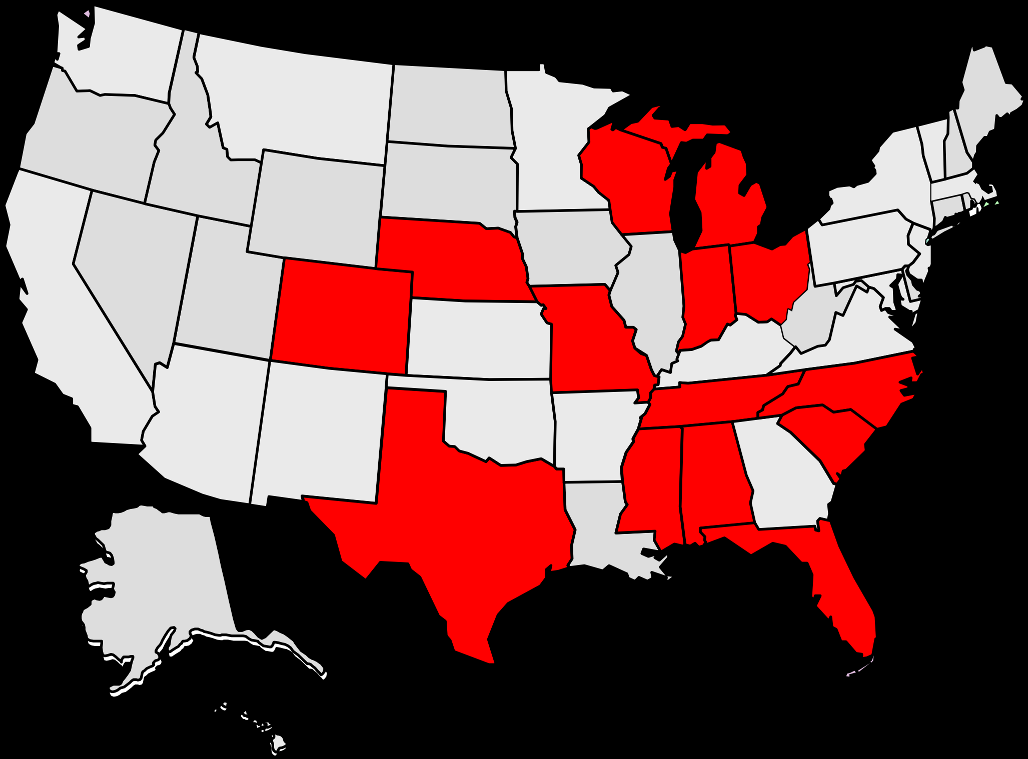
WMA Performance

- No long term performance
- Early performance looks good
- Some concern about moisture susceptibility based on lab results
  - No indication of any moisture related problems from early field performance

NCAT 2006
WMA Laboratory Study

- Evaluate Warm Asphalt Technologies for Paving Practices in the U.S.
  - Compaction
  - Quick “turn-over” to traffic
  - Rutting
  - Resilient modulus (for pavement design)
  - Moisture damage
- Products Evaluated
  - Aspha-min zeolite
  - Sasobit
  - Evotherm

WMA Field Projects NCAT has Visited



- Work in conjunction with FHWA
- Document and evaluate field projects
- Sample mix(es) for performance tests
- Revisit existing WMA sites for performance evaluations

Bridgeport, Texas

- Sunmount Construction
  - Summer 2008
- PG 76-22 with Evotherm DAT
- About 30,000 tons
- Temperature between 250-240 F
- No density issues
  - Average=93%

Graham, Texas

- RK Hall
  - Summer 2008
- PG 76-22 and Astec Double Barrel Green System
- Project was about 75,000 tons
- Temperature was between 260-275 F
- Removed one roller

WMA: Birmingham, Alabama

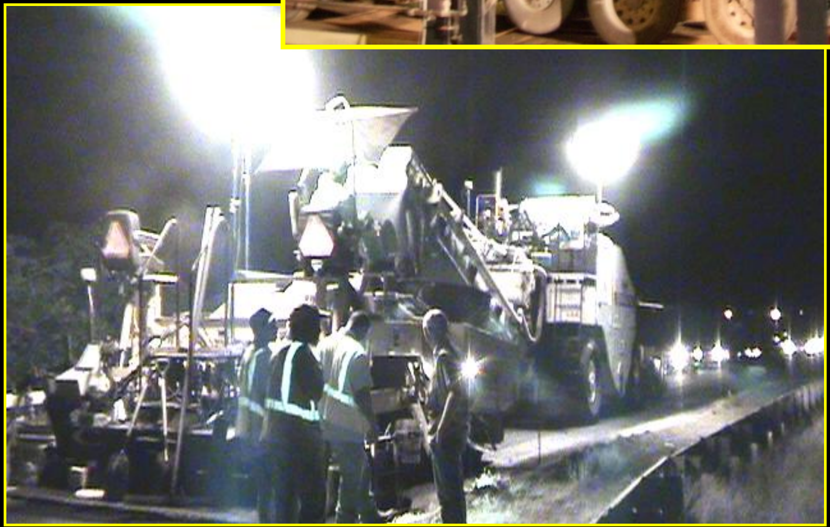
Materials

- **Limestone**
- **RAP**
  - 10% → HMA
  - 15% → WMA
- **RAS**
  - 5% →HMA
- **Base binder**
  - PG 67-22
- **Evotherm DAT**

WMA: Birmingham, Alabama

Construction

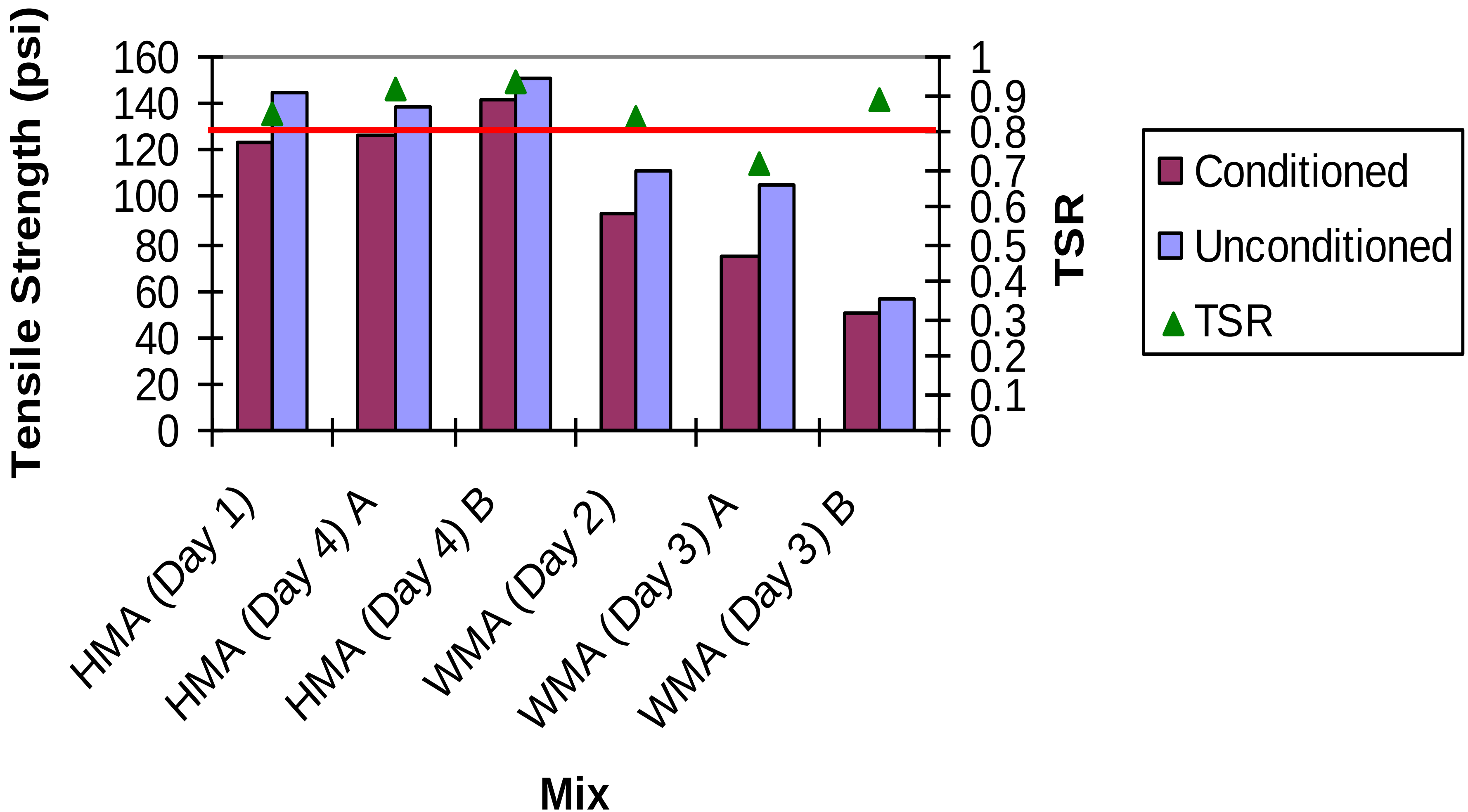
- Four nights of paving
  - August 26, 27, 28, 30
- Two test strips
  - ~500 tons
  - August 26 → HMA
  - August 27 → WMA
- Two full lengths
  - ~1200 tons
  - August 28 → WMA
  - August 30 → HMA



WMA: Birmingham, Alabama
NCAT Mobile Laboratory

- Moisture susceptibility
- Hamburg
- APA
- Rice and Bulks
- Dynamic Modulus
- Creep Compliance and Strength

WMA: Birmingham, Alabama
Moisture Susceptibility Testing



WMA: Birmingham, Alabama

Hamburg

- Rutting and stripping inflection point
- Stripping inflection point greater than 10,000 is good
- Rut depth less than 10 mm good

WMA: Birmingham, Alabama

Hamburg Rut Test

Material	Average Air Void Content (%)	Stripping Inflection Point (Cycles)
HMA (Day 1)	7.1	≥10,000
WMA (Day 2)	6.8	6860
WMA (Day 3)	7.3	≥10,000
	6.5	5290
HMA (Day 4)	7.2	≥10,000
	9.5*	N/A

*Not tested due to high air voids

WMA: Birmingham, Alabama
APA (rut test)

- Rutting
- Tested dry at 64 C
- Rut depth less than 8 mm is good

WMA: Birmingham, Alabama

APA Rut Tester

Mix	Sample	Average Rut Depth (mm)
HMA Day 1)	1	1.89
WMA (Day 2)	1	4.97
WMA (Day 3)	1	2.67
WMA (Day 3)	2	4.07
HMA (Day 4)	1	2.33
HMA (Day 4)	2	3.56

WMA: Birmingham, Alabama

Extraction and Recoveries

Material	Sample Number	Binder PG
HMA (Day 1)	1	88 - 16
	2	76 - 16
WMA (Day 2)	1	70 - 22
	2	70 - 22
WMA (Day 3)	1	70 - 22
	2	70 - 22
	3	70 - 22
	4	70 - 22
HMA (Day 4)	1	94 - 10
	2	76 - 16

NCAT Test Track

WMA Constructibility Study (1 month)

N_{design} = 80 for all mixes

	N2	N1
1"	9.5 mm NMAS HMA Control PG 67-22	9.5 mm NMAS Evotherm PG 67-22+ 3% Latex
2"	19.0 mm NMAS w/ Evotherm PG 67-22	
2"	19.0 mm NMAS w/ Evotherm PG 67-22	

NCAT Test Track

WMA Performance Study (ongoing)

N_{design} = 80 for all mixes

	E9	E10
2"	9.5 mm NMAS Isotherm PG 67-22	9.5 mm NMAS Isotherm PG 67-22+ 3% Latex
20+"	Perpetual Pavement	

WMA questions

- Less short-term aging
- Stiff mixes not compacting well at lower temperatures
- How do we conduct WMA mix designs?
- At what temperature should QC/QA specimens be compacted?
- How will WMA pavements perform?
- Are new WMA technologies good candidates?
- What plant issues may be encountered with WMA production and how can these problems be resolved?

NCAT Test Track RAP Study

RAP study objectives:

- Assess constructability of high RAP mixes
  - Mix design issues
  - Plant issues
  - Paving and compaction
- Accelerated Traffic Performance
  - Compare rutting over time
  - Compare cracking and durability
- Determine the appropriate grade of virgin binder needed for High RAP mixes.

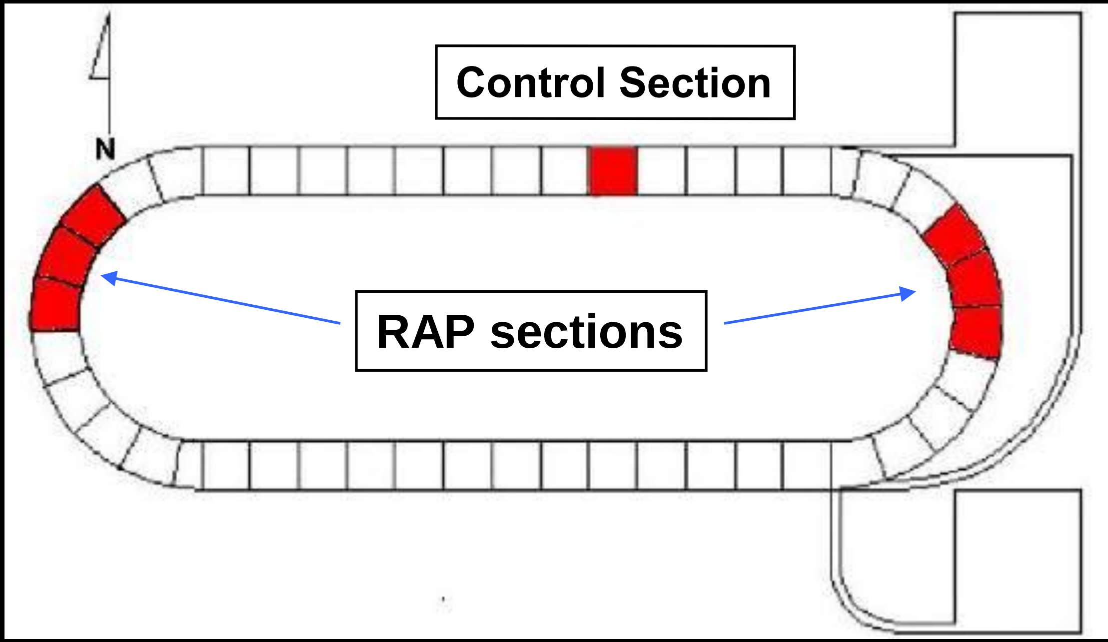
NCAT Test Track RAP Sections

1. virgin control mix with PG 67-22
2. 20% RAP with PG 67-22 virgin binder
3. 20% RAP with PG 76-22 virgin binder
4. 45% RAP with PG 52-28 virgin binder
5. 45% RAP with PG 67-22 virgin binder
6. 45% RAP with PG 76-22 virgin binder
7. 45% RAP with PG 76-22 + Sasobit

All sections were placed as a 2” mill and fill on existing sections

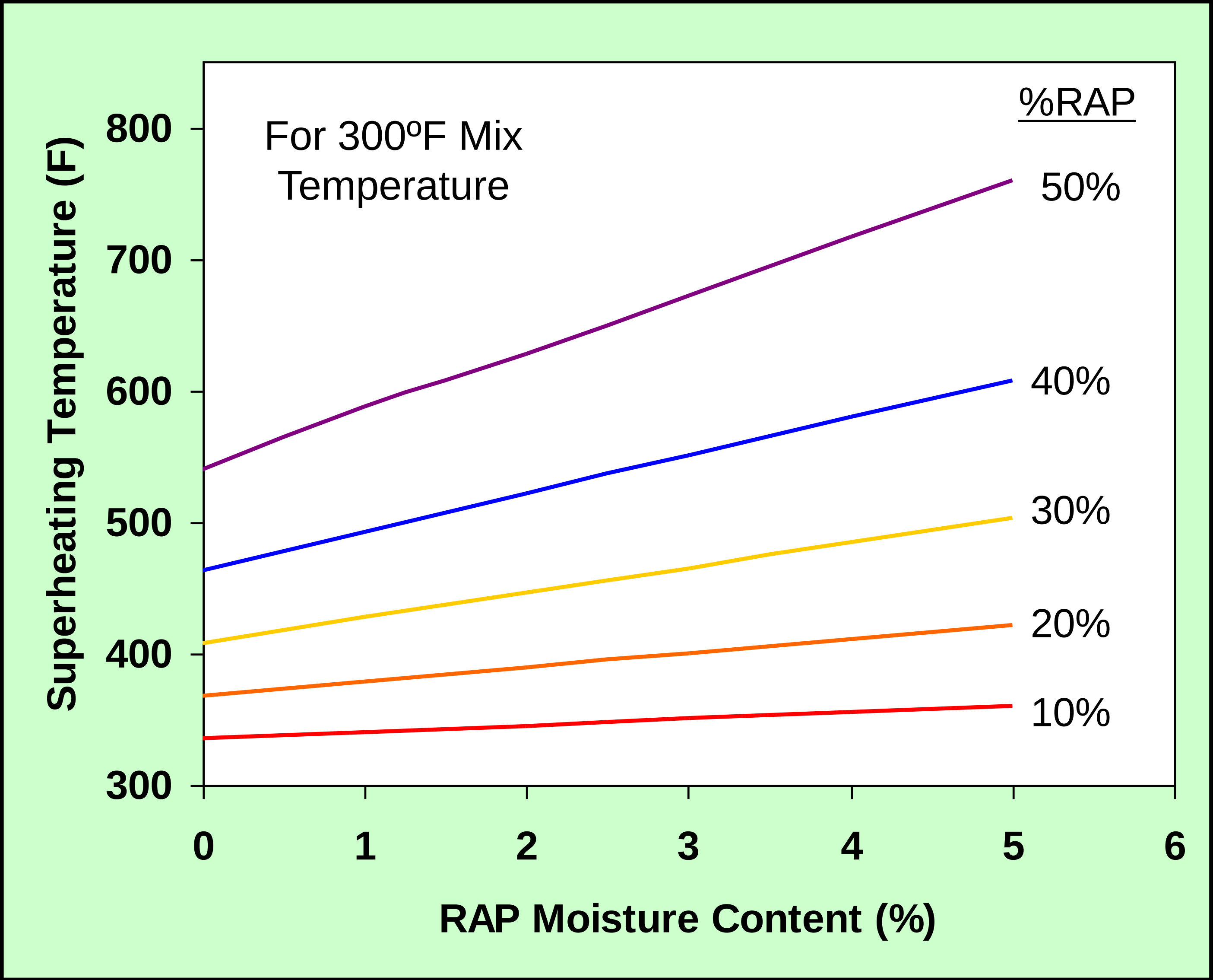
Evaluation of High RAP Mixtures

Section	Aggregate	Binder
N5	Virgin	PG 67-22
W4	20% RAP	PG 67-22
W3	20% RAP	PG 76-22
W5	45% RAP	PG 52-28
E5	45% RAP	PG 67-22
E6	45% RAP	PG 76-22
E7	45% RAP	PG 76-22 + Sasobit



- Very good rutting performance under heavy traffic and two hot summers
- Very minor cracking in only two sections. The cracks appear to be reflection cracks from previous HMA surface.

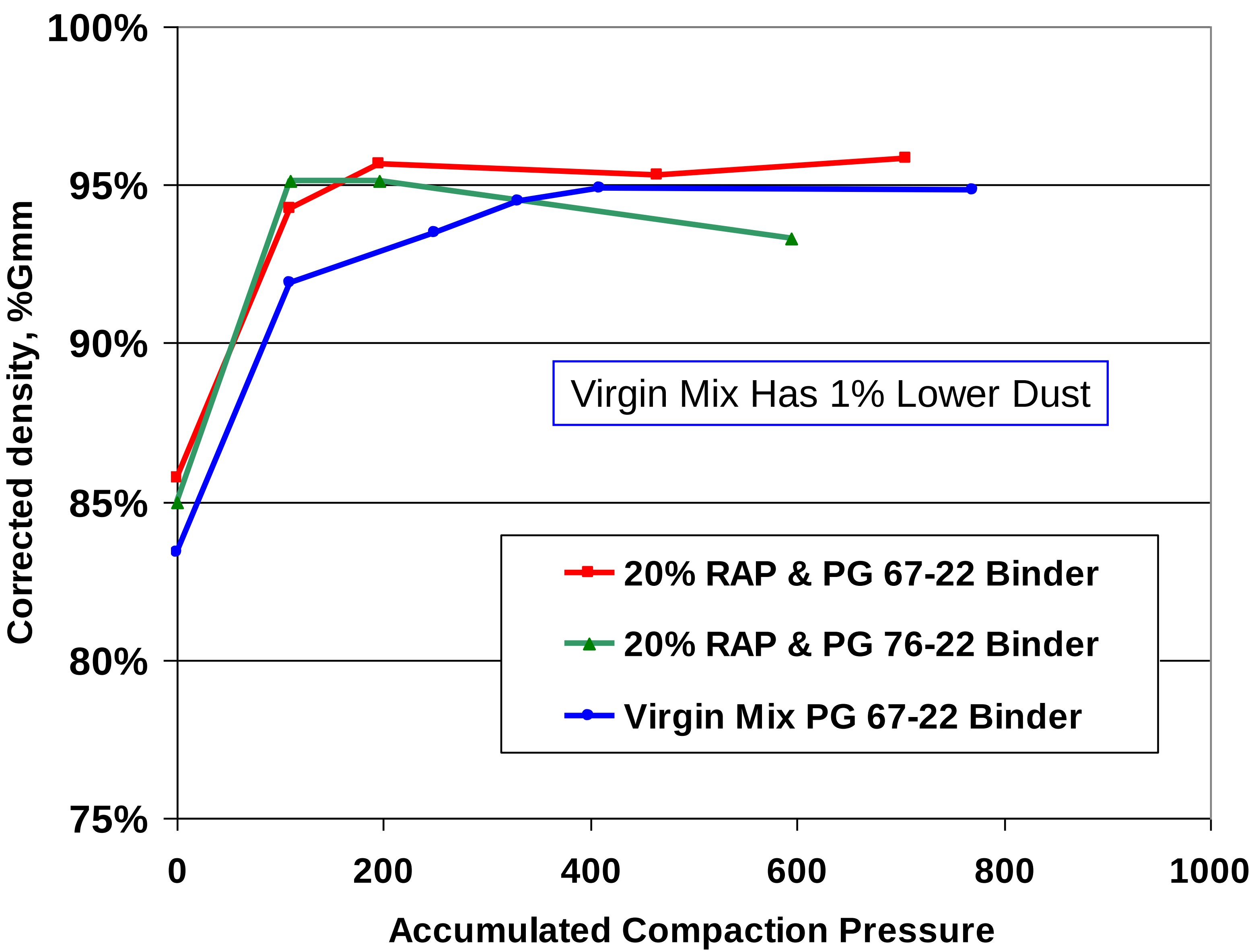
Superheating Requirements

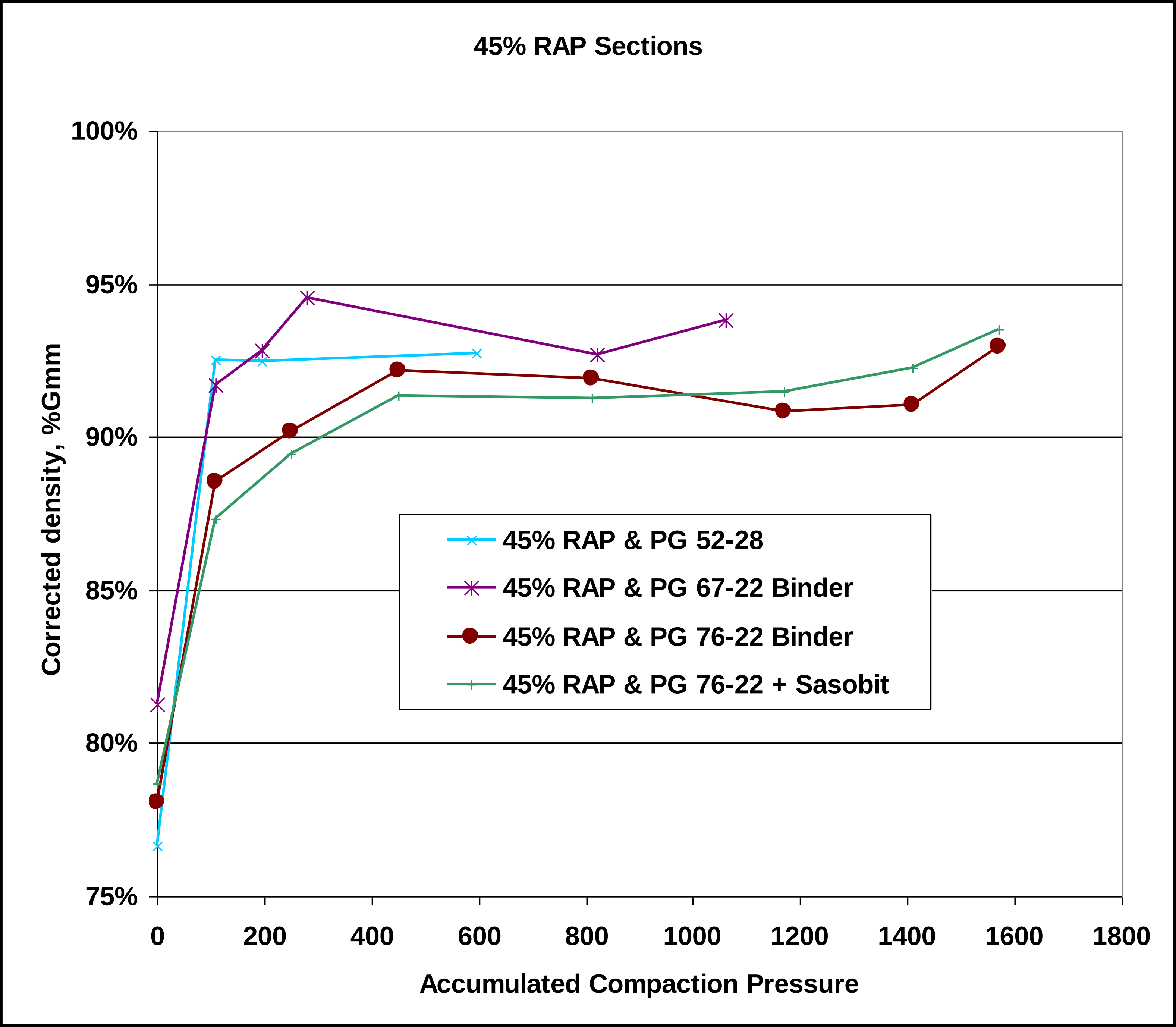


Predicted and Recovered Binder Grades

Section	%RAP[1]	%RAP Binder[2]	Virgin Binder		Virgin Binder + RAP	
			PG Grade	True Grade	Predicted Grade	Recovered Grade
W3	20%	18.2%	PG 76-22	78.1 -23.8	80.1 -22.4	78.1 -30.3
W4	20%	17.6%	PG 67-22	68.4-31.2	72.0 -28.6	74.2 -29.7
W5	45%	42.7%	PG 52-28	54.7-32.8	69.4 -25.8	74.1 -30.2
E5	45%	41.0%	PG 67-22	68.4-31.2	76.9 -25.1	80.9 -26.2
E6	45%	41.9%	PG 76-22	78.1-23.8	82.7 -20.7	85.5 -25.7
E7	45%	42.7%	PG 76-22 +1.5% Sasobit	83.2 -20.6	85.7 -18.8	86.3 -24.3
N5	0%	0%	PG 67-22	68.4-31.2	68.4 -31.2	71.1 -32.4

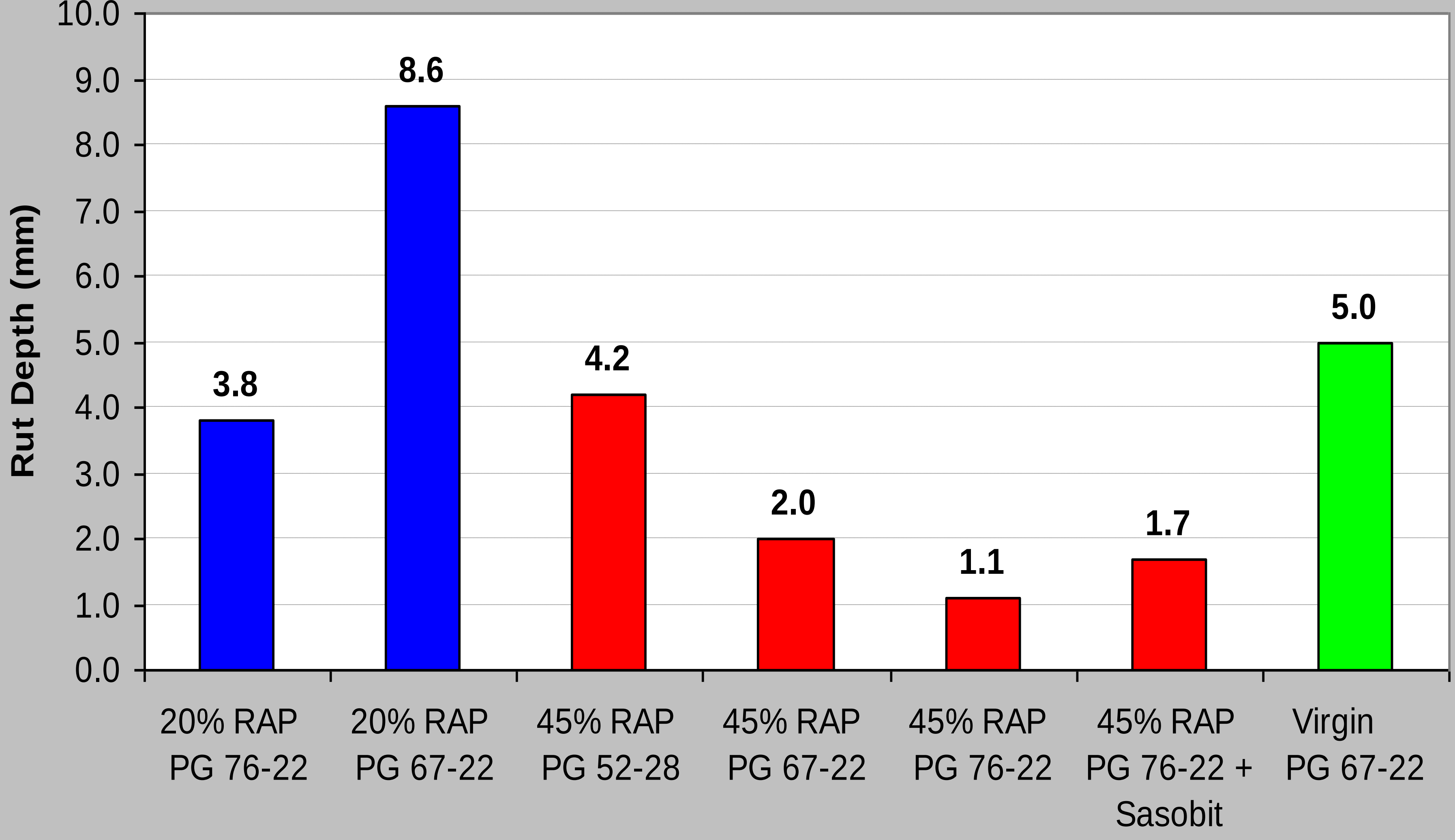
20% RAP & Control Sections



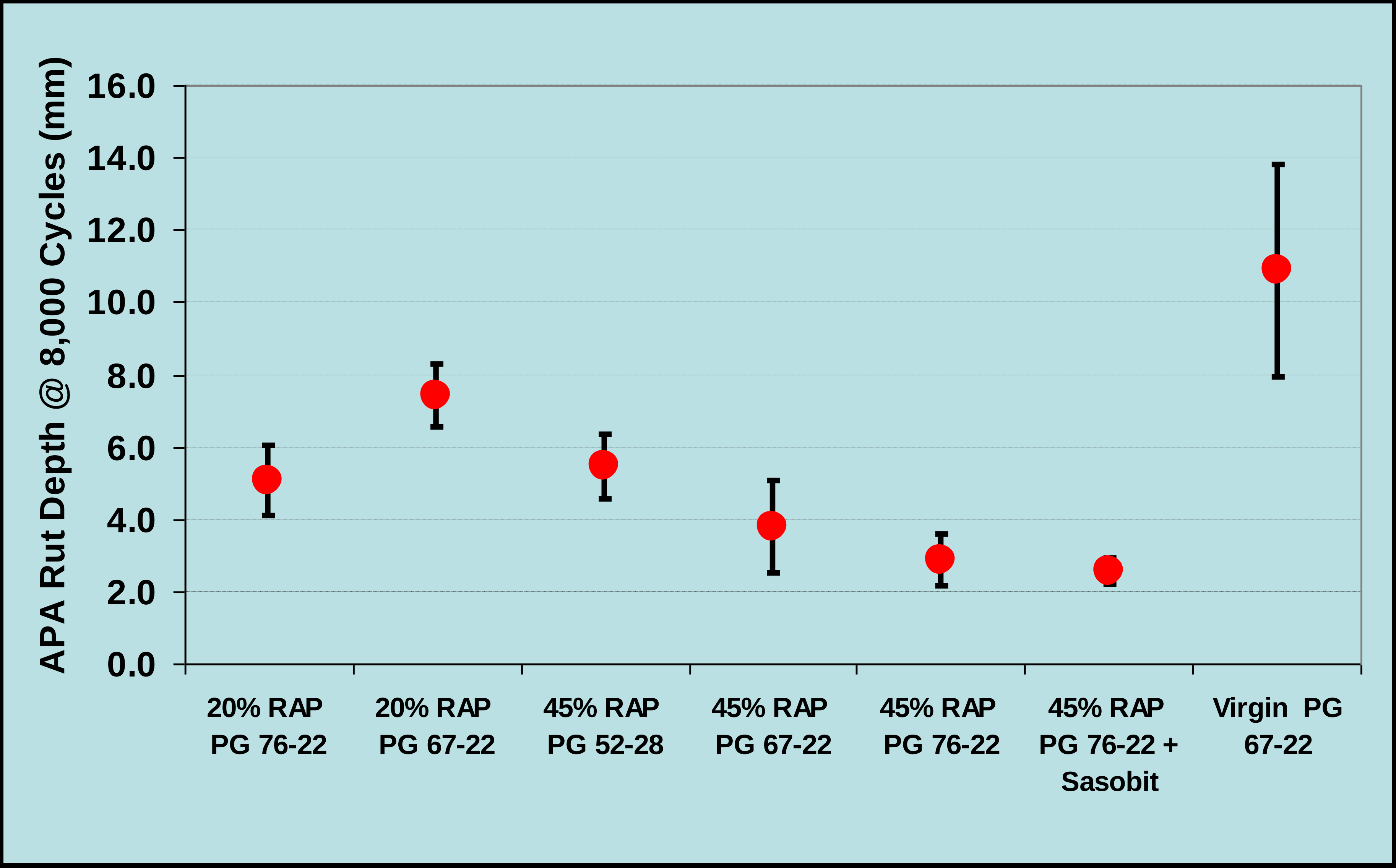

45% RAP Sections
100%
95%
90%
85%
80%
75%
Corrected density, %Gmm
0
200
400
600
800
1000
1200
1400
1600
1800
Accumulated Compaction Pressure
45% RAP & PG 52-28
45% RAP & PG 67-22 Binder
45% RAP & PG 76-22 Binder
45% RAP & PG 76-22 + Sasobit

2006 Research Cycle

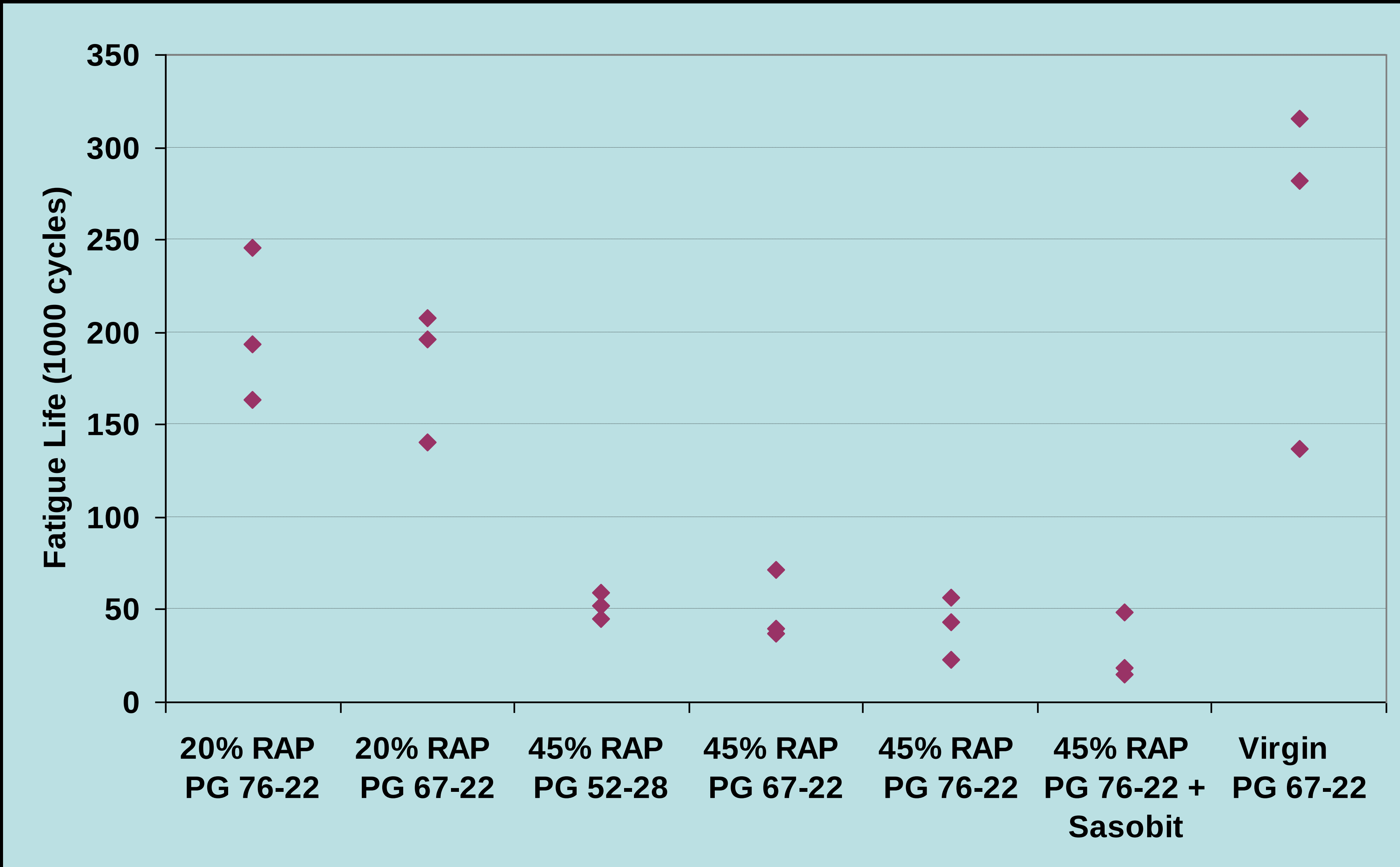
Rutting Performance @ 9.4M ESALs



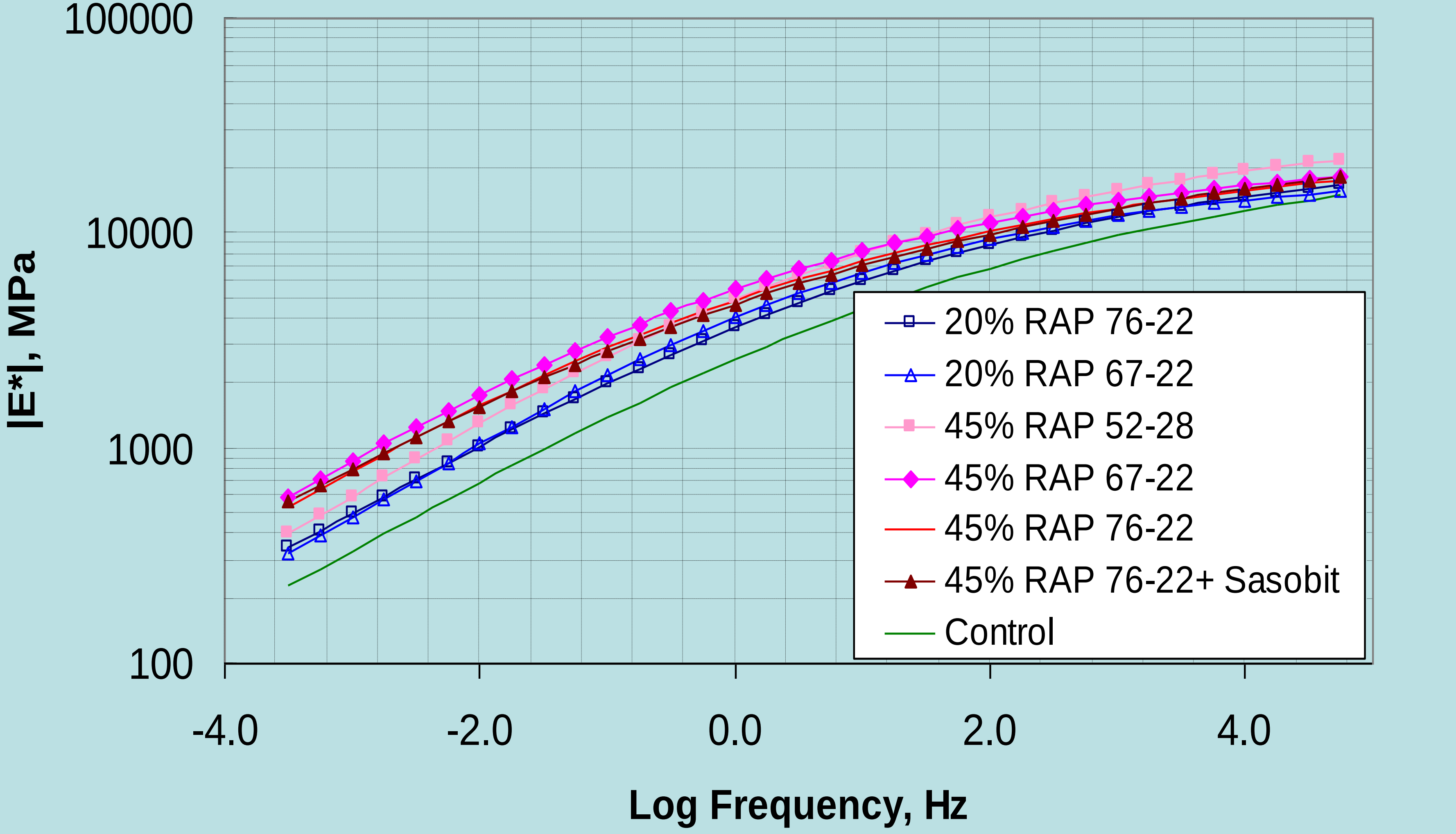
APA Rutting Test Results



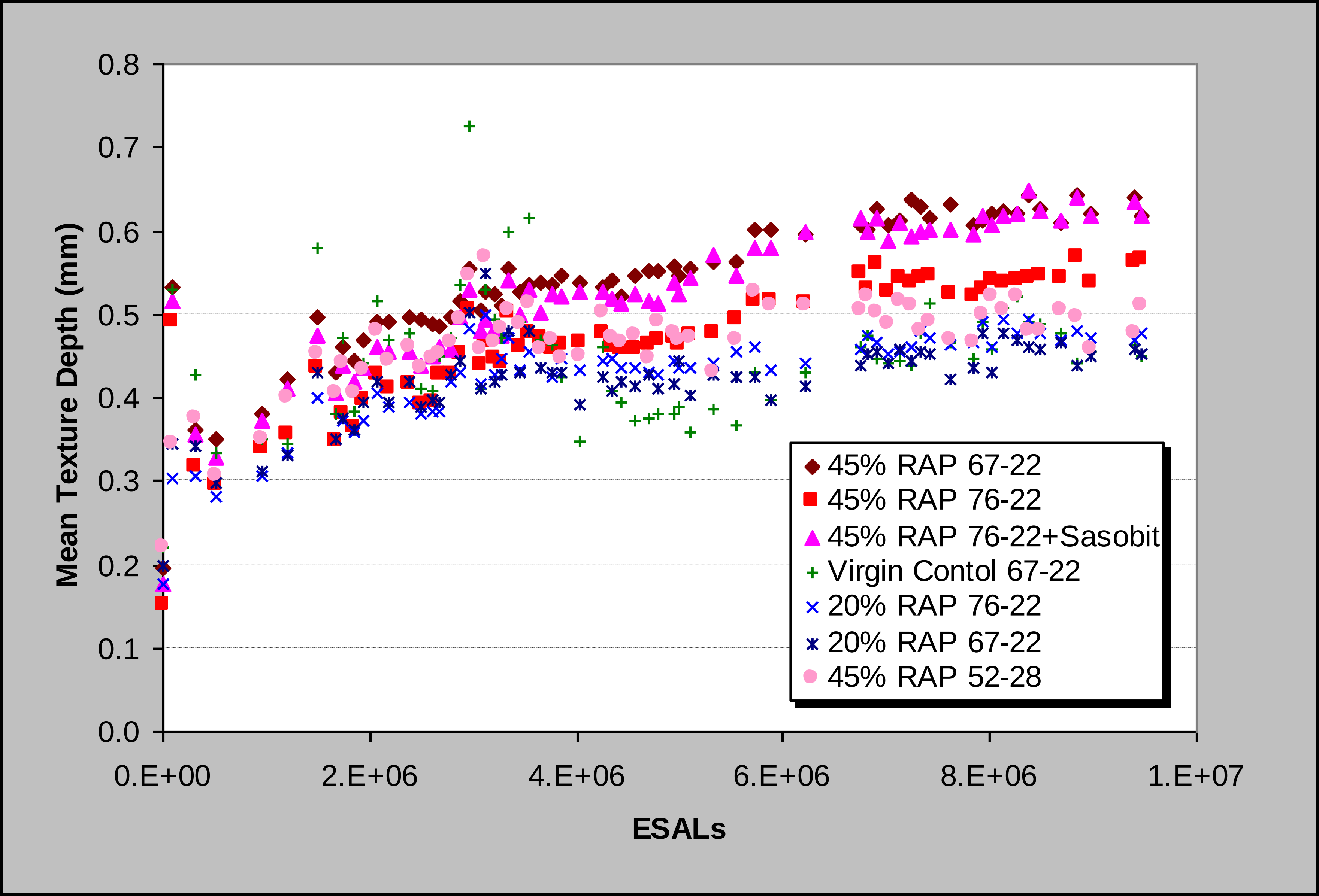
Beam Fatigue Test Results



Dynamic Modulus Master Curve



Change in Surface Texture



RAP questions

- RAP – impact of RAP binder on mixes requiring high binder modification – States are limiting “recycled” binder to 30%

NCAT Research Team

Mr. Don Watson

Dr. Buzz Powell

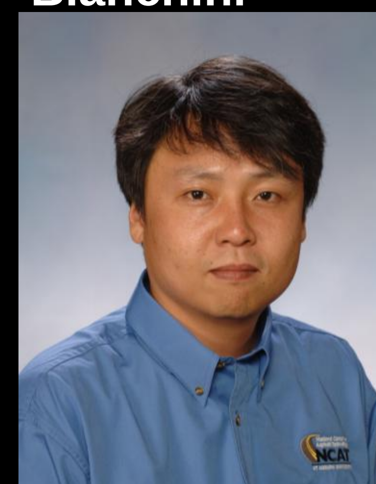
Dr. David Timm

Dr. Alessandra Bianchini

Dr. Andrea Kvasnak

Dr. Nam Tran

Dr. Mike Heitzman

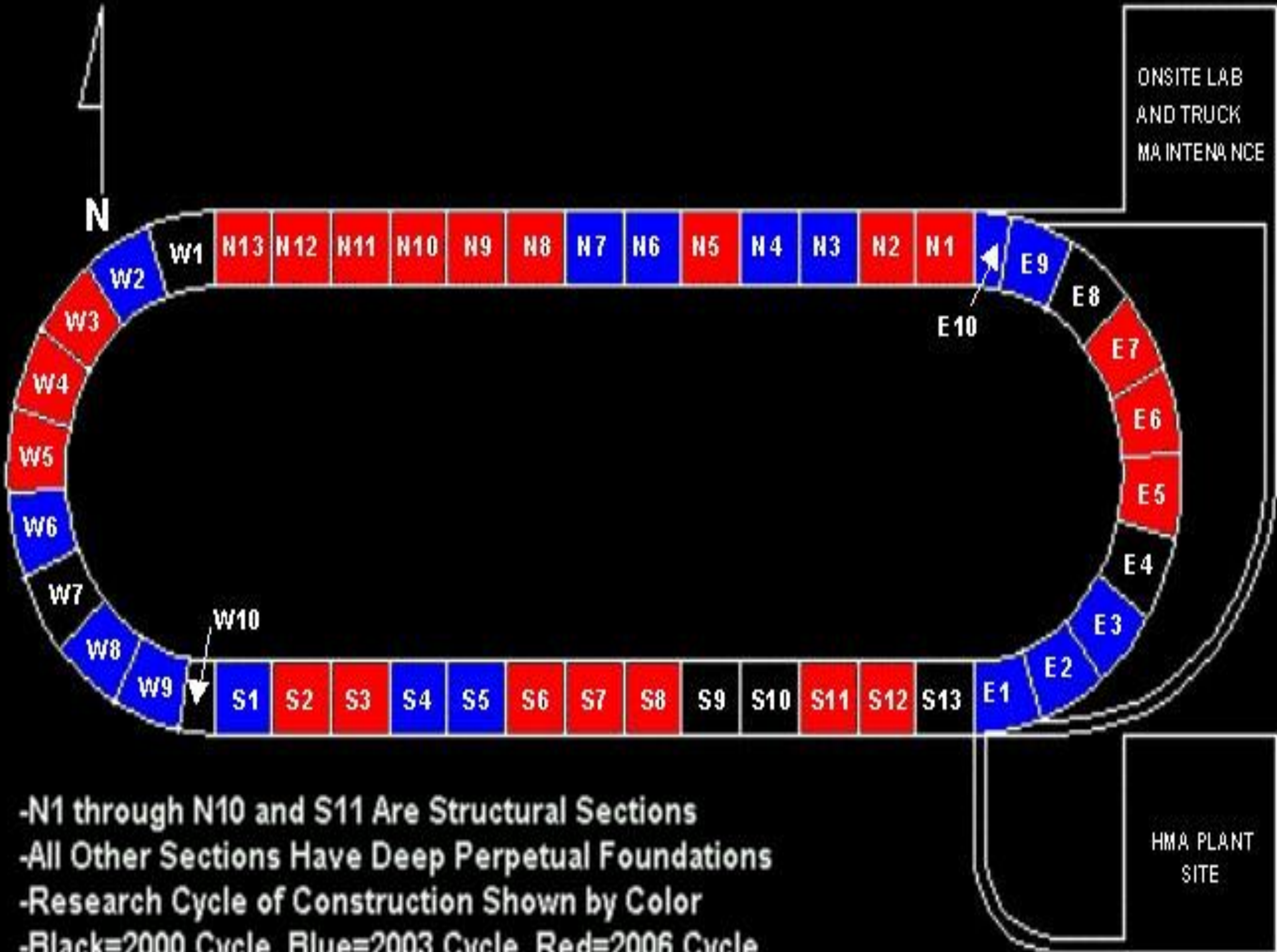


Dr. Jaeseung Kim

Current NCAT Research Studies

- Over 40 major active projects
- Focus Areas
  - Technician, Engineer, & Professor Training
  - Full scale, high speed pavement performance
  - MEPDG performance model calibration
  - Tire-Pavement noise analysis
  - RAP and WMA
  - Lab tests for predicting performance
  - Pavement reflectivity → UHI
  - Pavement surface friction
  - Plant production quality control
  - Pavement performance modeling


NCAT Test Track



- N1 through N10 and S11 Are Structural Sections
- All Other Sections Have Deep Perpetual Foundations
- Research Cycle of Construction Shown by Color
- Black=2000 Cycle, Blue=2003 Cycle, Red=2006 Cycle

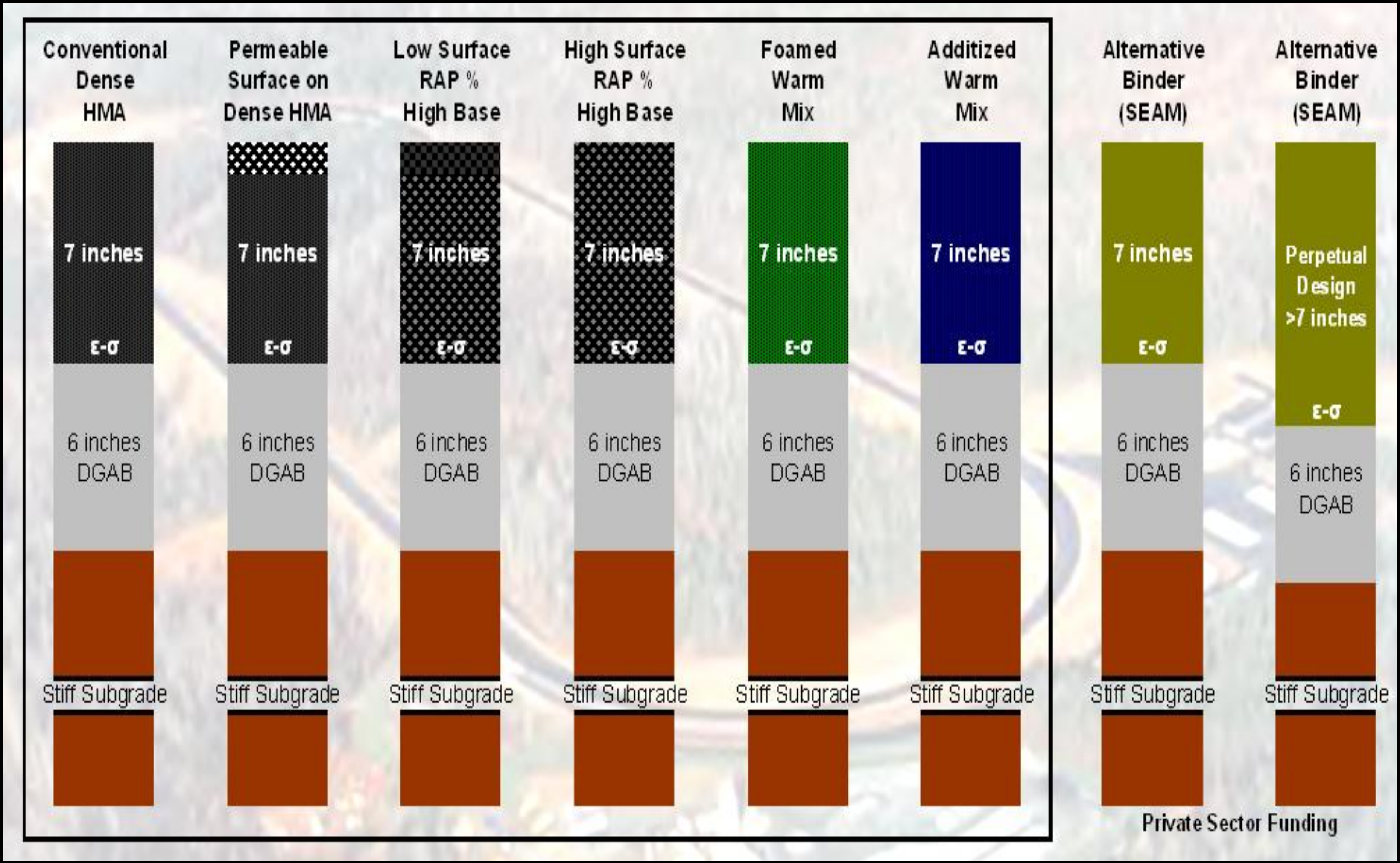
2006 Section Forensics

- Rutting via ARAN, dipstick, wire line, ALDOT
- Cores from end of section for density correlation
- Density via stationary & rolling nuclear, impedance
- Inertial profiling, noise, surface friction, grip testing
- Circular texture, dynamic friction, $\text{permeability}_{\text{OGFC}}$
- Extensive coring within sections to be reconstructed
- Select trenching as function of research need

2009 Research Cycle

- Begin hauling local mix aggregates January 2009
- Refurbish trucks & trailers January-February 2009
- Forensics and cleanup complete 2/6/09
- Test section removal can begin after conference
- Subgrade and base work March-April 2009
- Mix production and placement May-June 2009
- Target fleet operations July 2009

2009 Group Experiment



NCAT Test Track Website

www.pavetrack.com

NCAT Pavement Test Track

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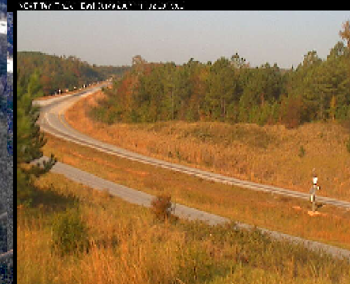

Aerial Photo of the 309 Acre Site (Click for Photo Album) Track Cam (Click for Live Feed)

HOTLINKS to download PAVE reports, review upcoming NCAT training courses, query historical weather data, view current color radar or preview local forecast.

4,563,503 ESALs as of 2300 hours on October 25, 2007 (46% of the 10,000,000 ESAL goal !).

WELCOME to the home page for the NCAT Pavement Test Track. The primary objective of this site is to effectively communicate our experiences to the world as we administer research designed to extend the life of flexible pavements. Experimental mixes on our 1.7 mile oval are installed in 200 ft test sections that facilitate meaningful field performance comparisons, and laboratory testing is conducted on samples made during construction to facilitate practical lab to field performance correlations. We appreciate your interest and value your feedback. While you are here, we would appreciate you taking the time to participate in a brief web survey that will help us to propose effective experiments for the 2009 Track.

CONSTRUCTION - Reconstruction of the 2006 experiment was completed on October 19, 2006 by East Alabama Paving, who was selected as the contractor via a competitive bidding process on 8/15/06. The third research cycle again consists of extended traffic sections, new mix performance sections, and instrumented structural sections (on the Track as well as on remote, open roadways). The instrumented structural sections are part of a larger, multi-state validation effort for mechanistic-empirical pavement design. Fleet operations began on November 10, 2006 after finish work (shoulders, striping, etc.) had been completed and the trucks were ready to roll. Another 10 million ESALs is planned to be completed by the fall of 2008. The planning process is now underway for the fourth research cycle, which will be built in 2009.

For more details - contact

- Dr. Andrea Kvasnak (RAP & WMA)
- Dr. Buzz Powell (Test track)


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