Highly Modified Asphalt HiMA/PG 64E-40 Mixtures

Alaska Asphalt Summit

November 10, 2015

Chris Lubbers,
Kraton Polymers

Highly Modified Asphalt - HiMA

What Is It?

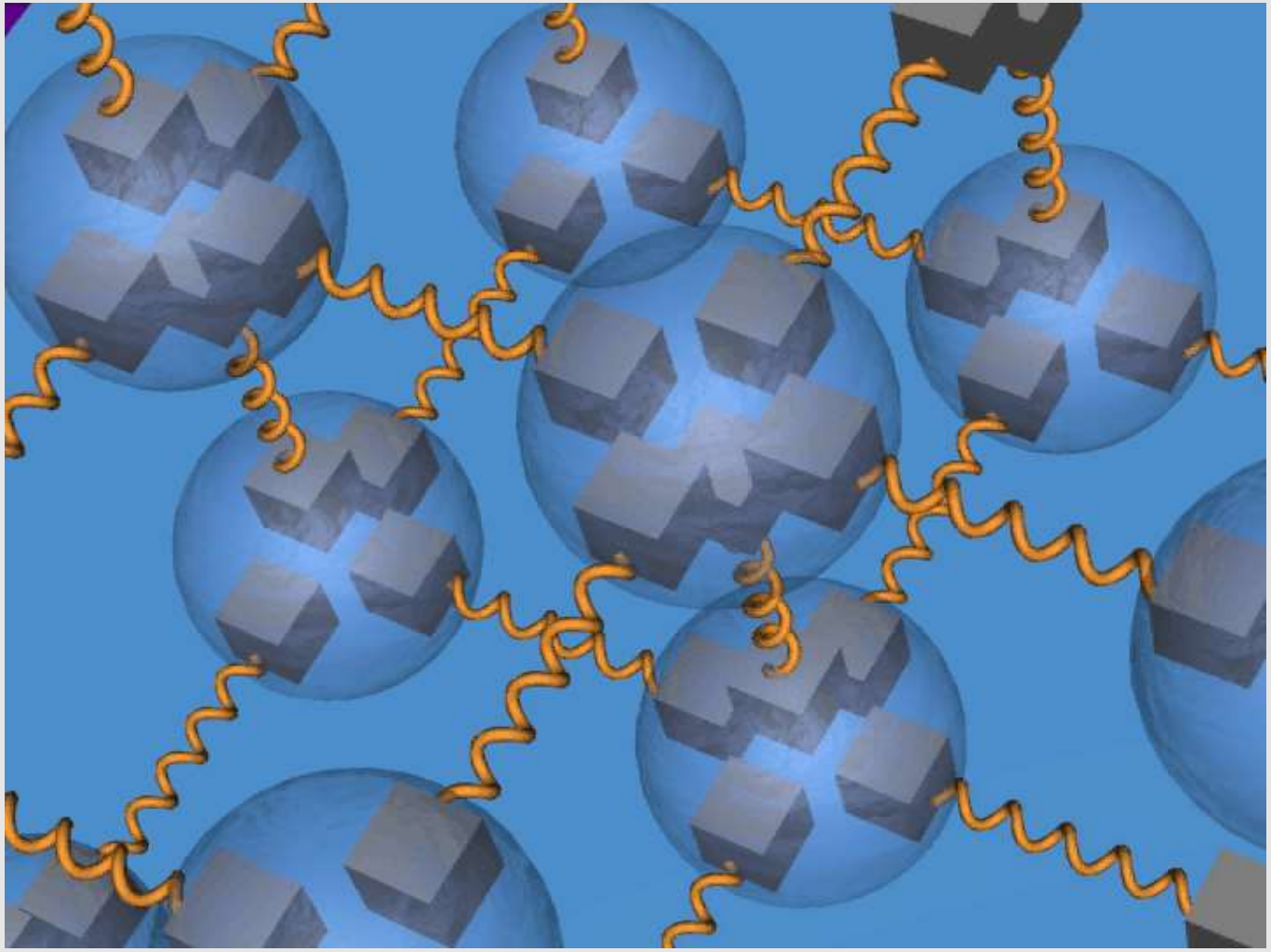
What Are the Market Applications?

How Has It Performed in Structural Applications?

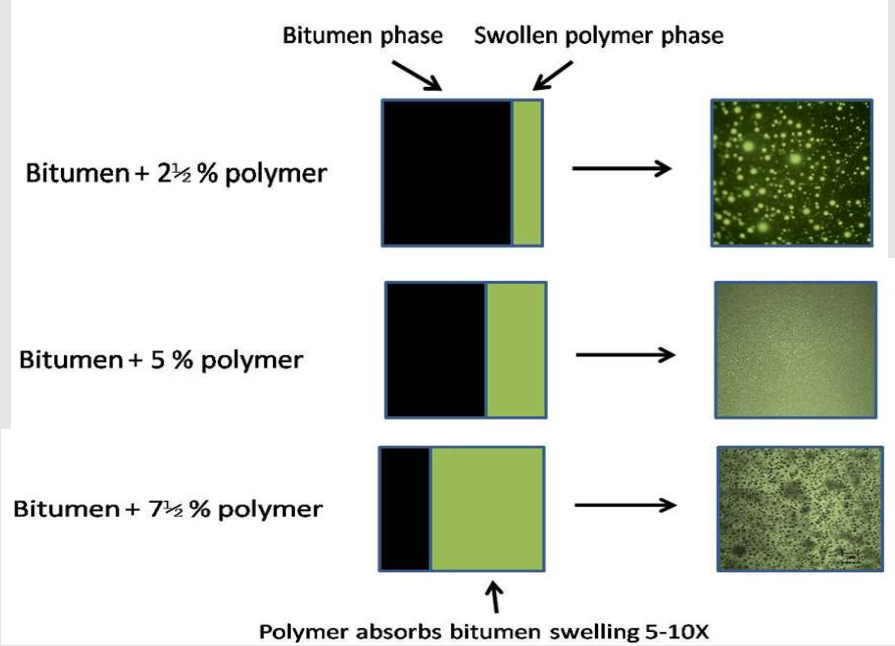
HiMA Projects in RMAUPG region

How Do You Do Pavement Design with HiMA?

SBS in Bitumen

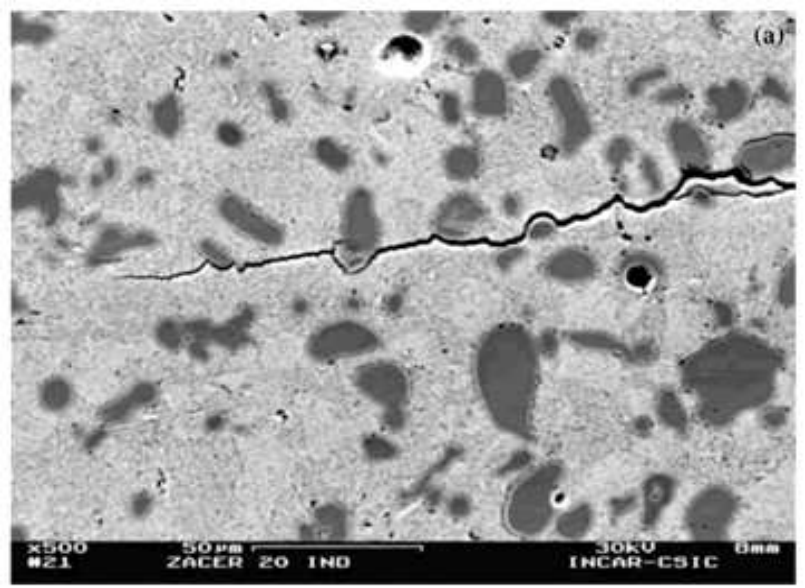


What Is Highly Modified Asphalt?



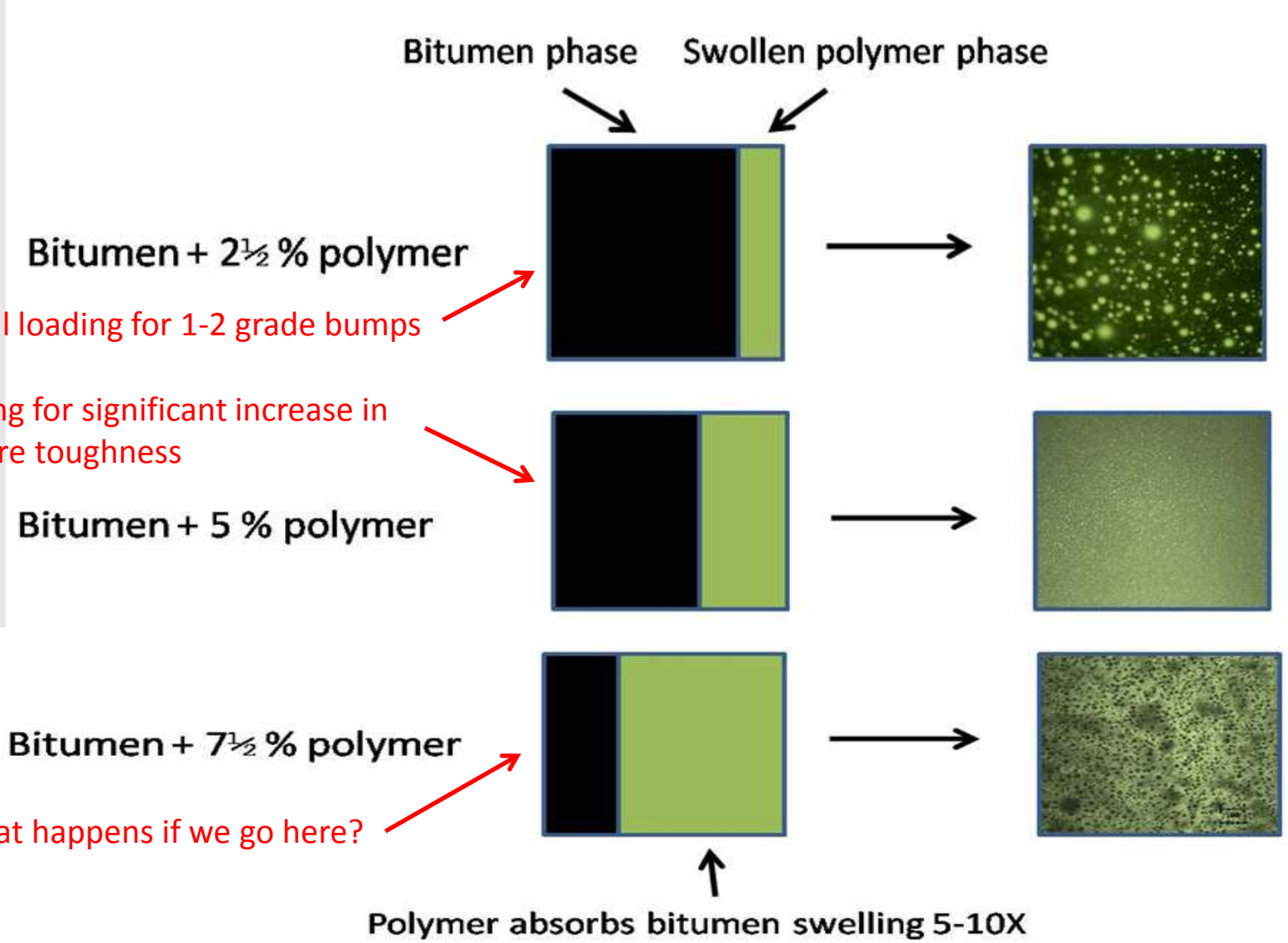
Highly Modified Asphalt is exactly what it says, asphalt with more than double the normal amount of SBS polymer.

This gives a much denser polymer network with up to 10X rutting **and** fatigue cracking resistance.

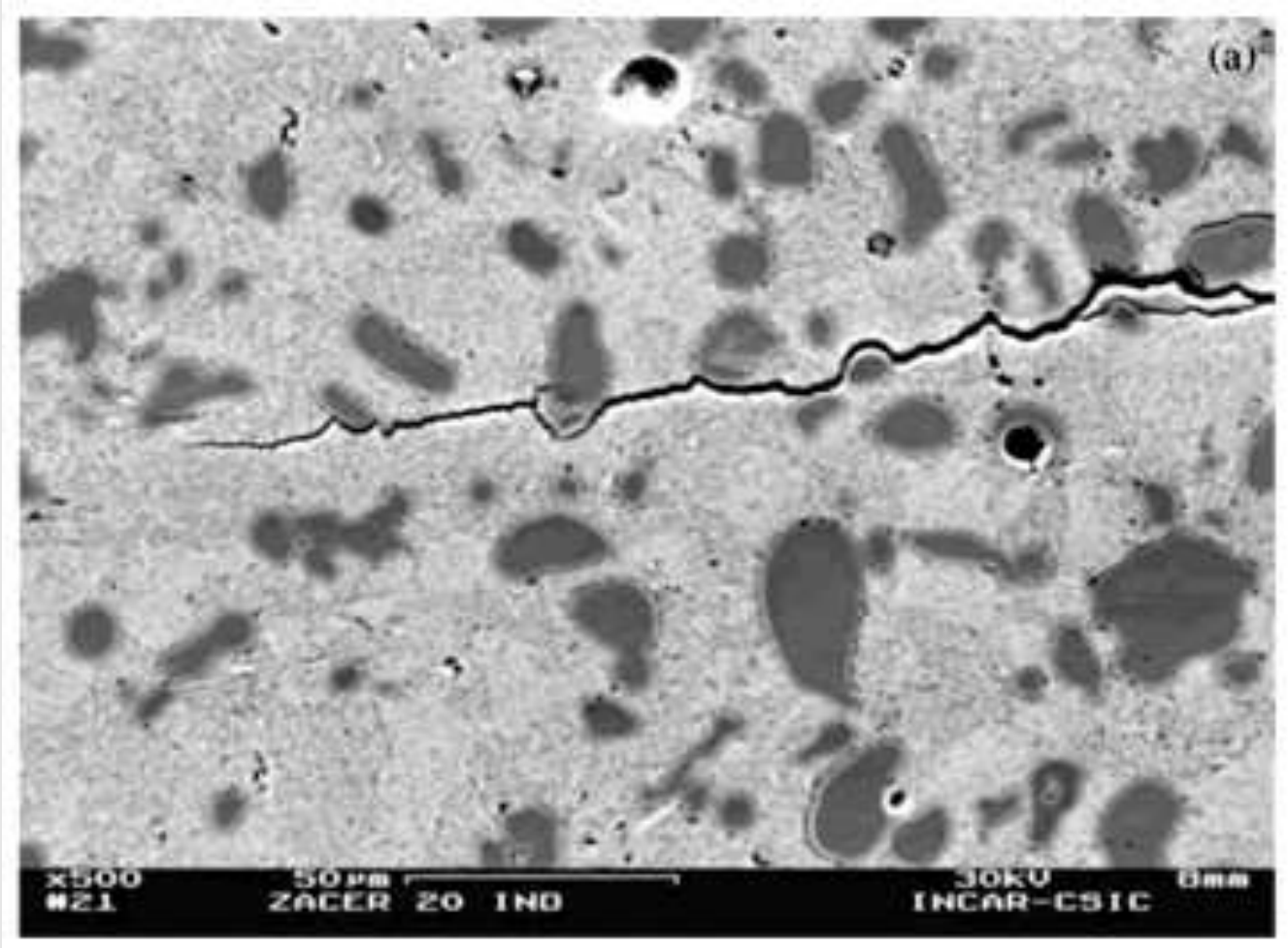


Over 500,000 tons in over 70 projects around the world have demonstrated **superior performance** at **reduced thickness**.

Phase Morphology

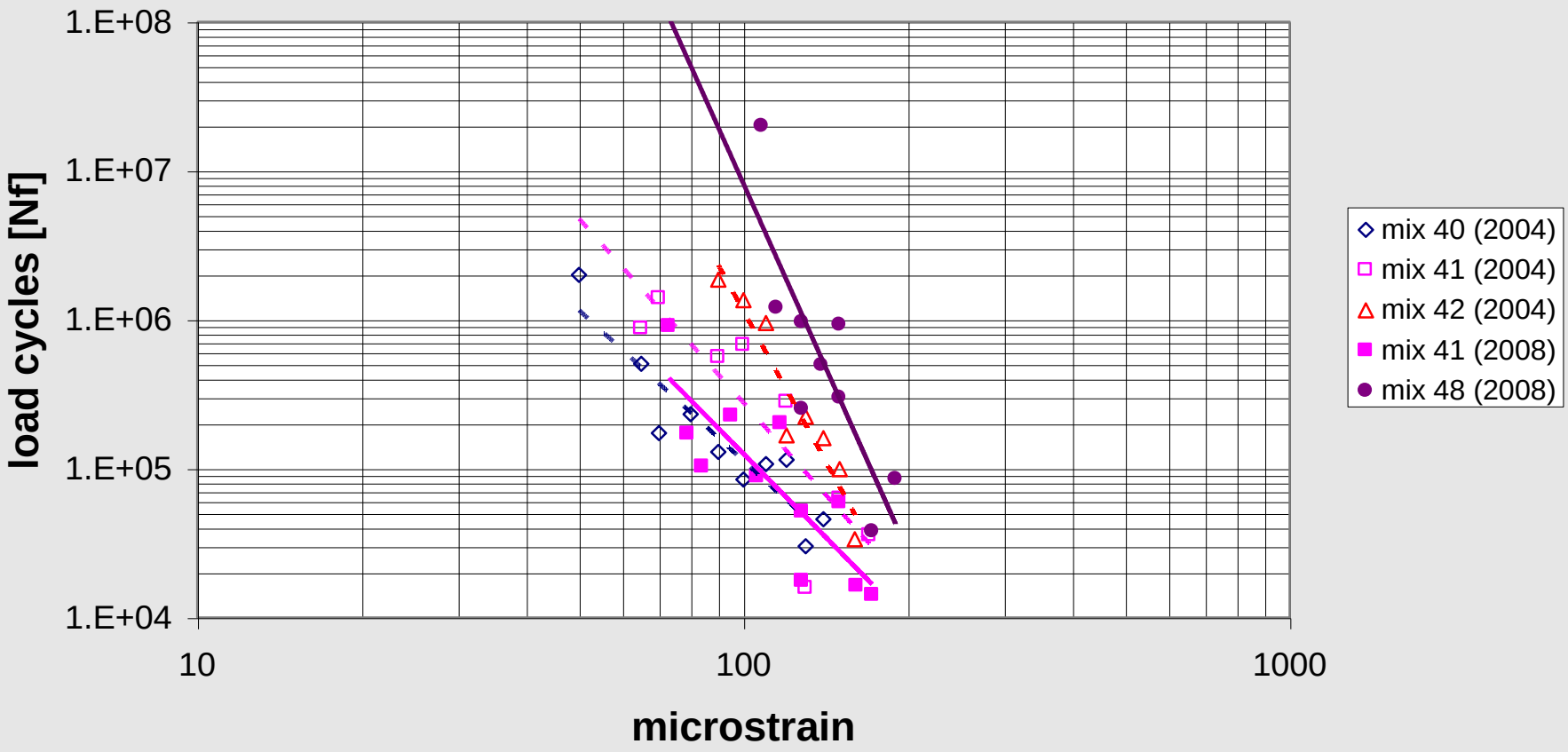


Crack Propagation in Toughened Composite



S. López-Esteban, J.F. Bartolemé, C. Percharromán, S.R.H. Mello Castanho, J.S. Moya, *Wet Processing and Characterization of ZrO_2/Stainless Steel Composites: Electrical and Mechanical Performance*, Materials Research, Vol. 4, São Carlos, July 2001. Used with permission.

Four Point Bending Beam Fatigue Results



Full sinusoidal loading. Cited strains are ½ amplitude

Comparative Damage

ACRe 3D Finite Element Modeling

Distress	10”unmodified	6” HiMA
Shear deformation	1	0.38
Compressive deformation	1	0.55
Longitudinal cracking	1	0.02
Vertical cracking	1	0.57
Transverse cracking	1	0.09

HiMA Market Applications – Where Does it Add Value?

Structural Applications

- With a sound base, thinner pavements with lower upfront cost
- Demonstrated in many field applications & Ohio University APLF
- With weak base, much longer lifetime can be achieved

Thin Overlays

- Superior resistance to reflective cracking BUT requires finer, richer mix.

Preservation Surfacing such as SmoothSeal

Open Grade Mixes for Reduced Raveling

SAMI Layers

High Stress Applications – ramps, intersections

AASHTOWare® Pavement ME Design works for HiMA designs

HiMA Usage in North America

- HiMA projects in 20 states now: AK, AL, FL, GA, IA, MA, MN, MO, NC, NH, NJ, NY, OH, OK, OR, TN, UT, VA, VT, WA
- Notable projects—
    - Interstate 10 in Oklahoma
    - Interstate 95 in Virginia
    - 1st Avenue in New York City
    - Interstate 59 in Alabama (2016)
- PG specifications in most, e.g., PG 76-34 (M320) or PG 76E-28 (M332)
- 15 different PMA suppliers
- Contractors' "How To" Guide
- Heavy usage in NCAT 2015 cycle

NCAT Trials

National Center for Asphalt Technology Auburn, Alabama

- 1.7 mile dedicated test track
- Full pavement lifetime simulated in 2+ years

Thin structural test section N7 (2009)

- 18% thinner pavement, 5 ¾” versus
- 7” control sections
- 1/3 as much rutting
- No cracking

Structural rehabilitation N8 (2010)

- Oklahoma sponsored section
- Standard rehab (2009) failed in 10 months
- HiMA rehabilitation 4 mm rutting and no cracking at 48 months

Continued N7 & N8 for 2012 cycle, continuing N7 with overlay for 2015 cycle

NCAT – Cross Sections Evaluated

S9 - Control 7” standard hot mix

1 ¼” (PG 76-22; 9.5mm NMAS; 80 gyrations)

2 ¾” (PG 76-22; 19mm NMAS; 80 gyrations)

3” (PG 67-22; 19mm NMAS; 80 gyrations)

N7 - 5 ¾” highly modified hot mix

1 ¼” (PG 76-22 E, 9.5 mm NMAS, 80 gyrations)

2 ¼” (PG 76-22 E,19mm NMAS; 80 gyrations)

2 ¼” (PG 76-22 E;19mm NMAS; 80 gyrations)

Dense Graded Crushed Aggregate Base
M_r = 12,500 psi
n = 0.40

Lift thicknesses limited by 3:1 thickness:NMAS requirement

6”

Test Track Soil
M_r = 28,900 psi
n = 0.45

Courtesy Prof. David Timm, Auburn U.

AASHTO M 332 Binder Properties at 64°C

Parameter	$J_{nr0.1}$ (kPa^{-1})	$J_{nr3.2}$ (kPa^{-1})	J_{nrdiff} (%)	R0.1 (%)	R3.2 (%)
Value	0.004	0.013	200.7	98.6	96.4

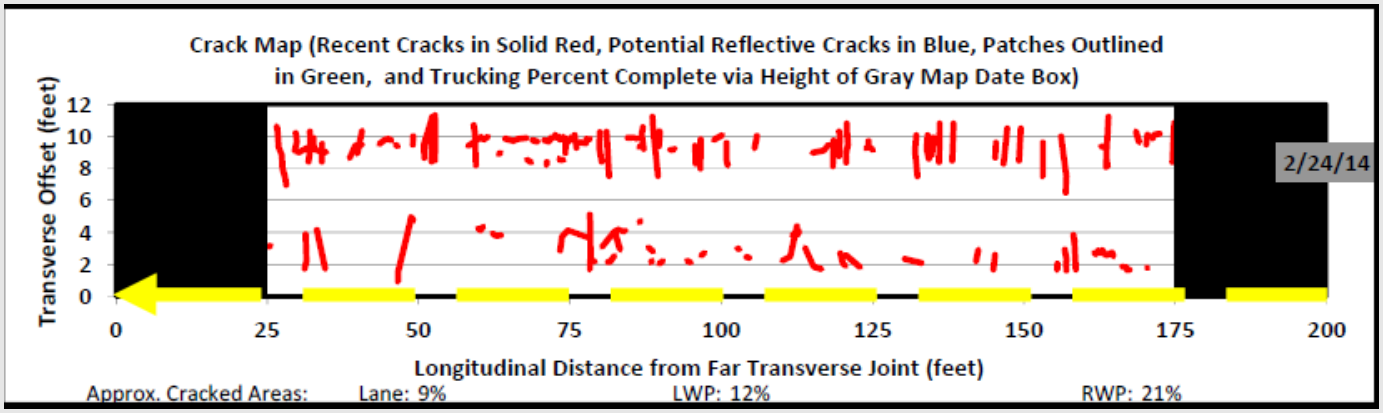
Typical specification – PG 76E-22 or PG 76E-28

with $J_{nr3.2} \leq 0.1\ kPa^{-1}$ $R_{3.2} \geq 90\%$

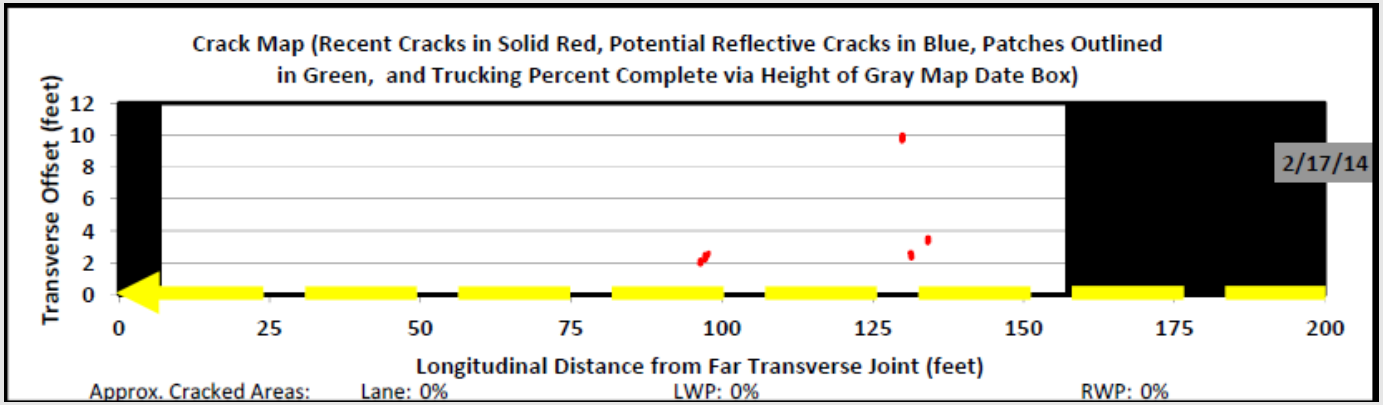
Relative Performance of Control S9 Section and Highly Modified N7 Section – 17 MM ESALs

3/14 Rutting | **2/14 Crack Maps**

S9 **6.0 mm**

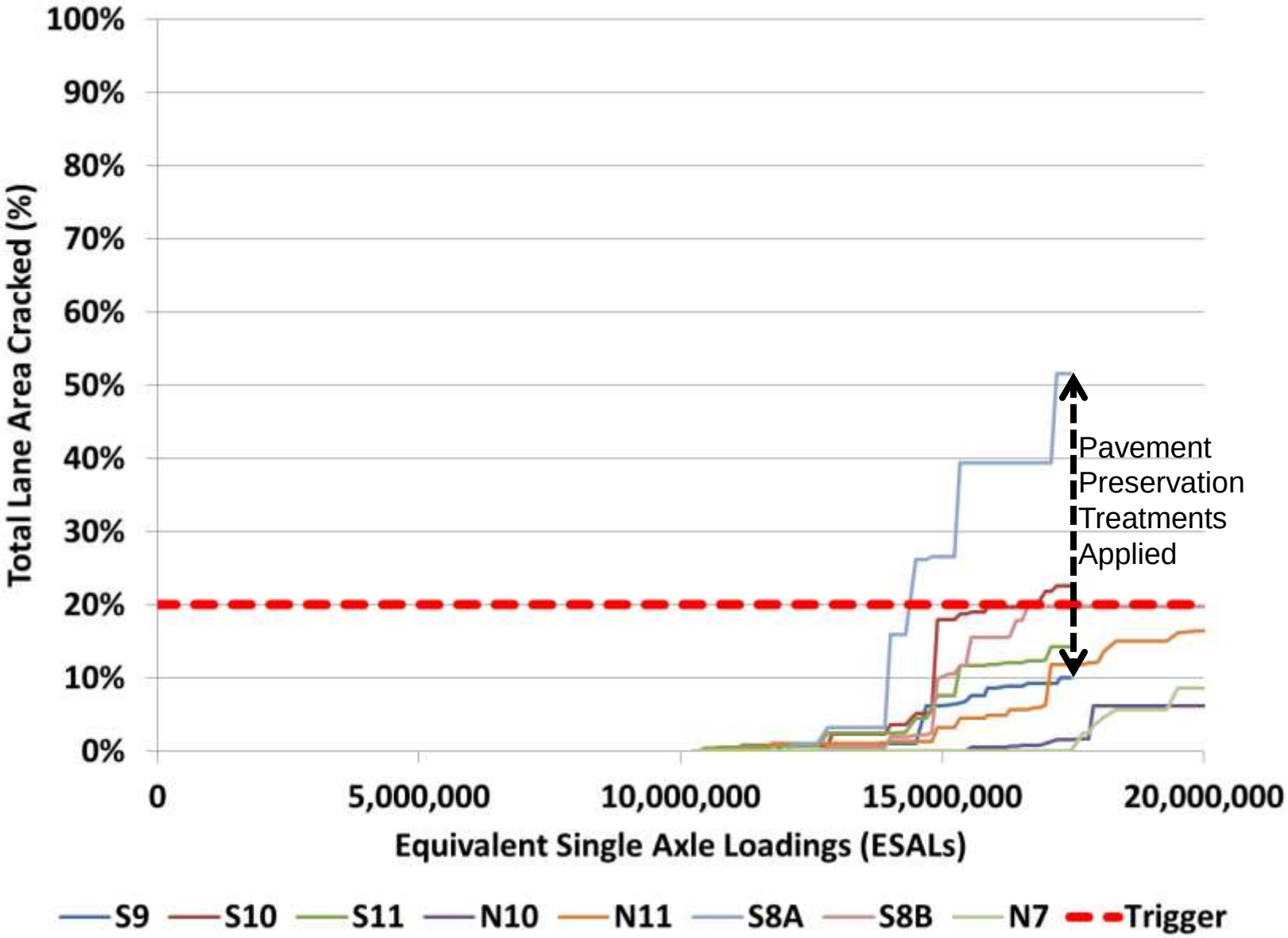


N7 **1.6 mm**



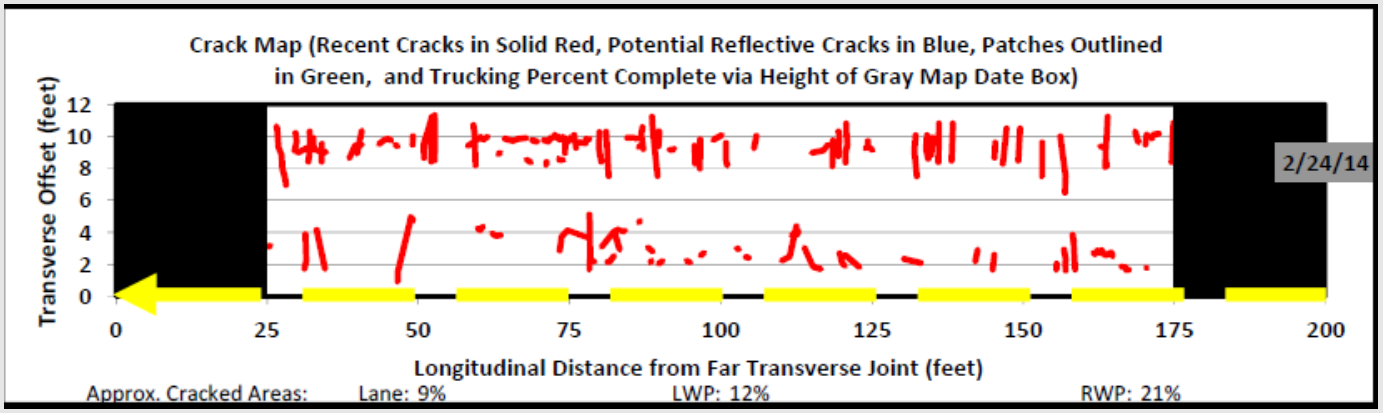
N7 showing a few hairline cracks that are not growing

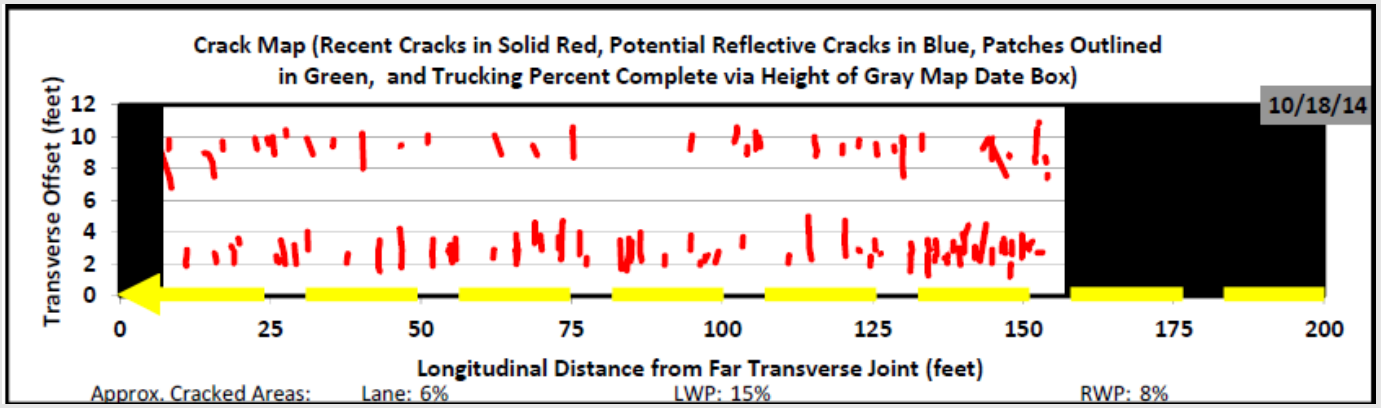
Materials


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Total Lane Area Cracked (%)
0
5,000,000
10,000,000
15,000,000
20,000,000
Equivalent Single Axle Loadings (ESALs)
Pavement Preservation Treatments Applied
S9
S10
S11
N10
N11
S8A
S8B
N7
Trigger

Relative Performance
Control S9 Section – 17 MM ESALS
vs. Highly Modified N7 Section – 20 MM ESALs

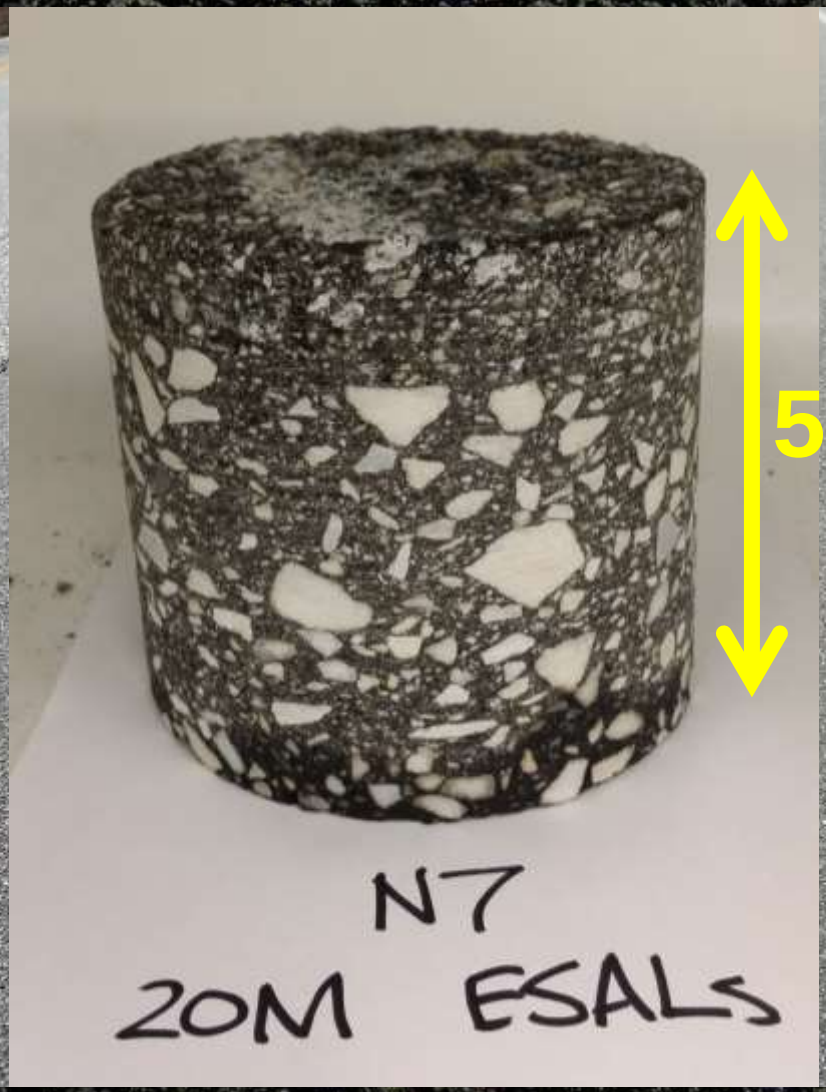
4/28/14 Crack Map





10/18/14 Crack Map

Materials



NCAT 2015 HiMA Sections

Section	Group	Surface	Binder	Base
N1	CG	Control	HiMA	HiMA
N2		High Density	HiMA	HiMA
N5		Low AC & Density	HiMA	HiMA
N8		20% RAP + 5% RAS	HiMA	HiMA
S5		35% RAP + PG 58-28	HiMA	HiMA
S6		HiMA	HiMA	HiMA
S8		HiMA	HiMA	Research Base
S13		AZ Rubber	HiMA	HiMA
N7	CA	5% RAS + >20% RAP + rejuvenator	HiMA (2009)	HiMA (2009)

RMAUPG Region Projects

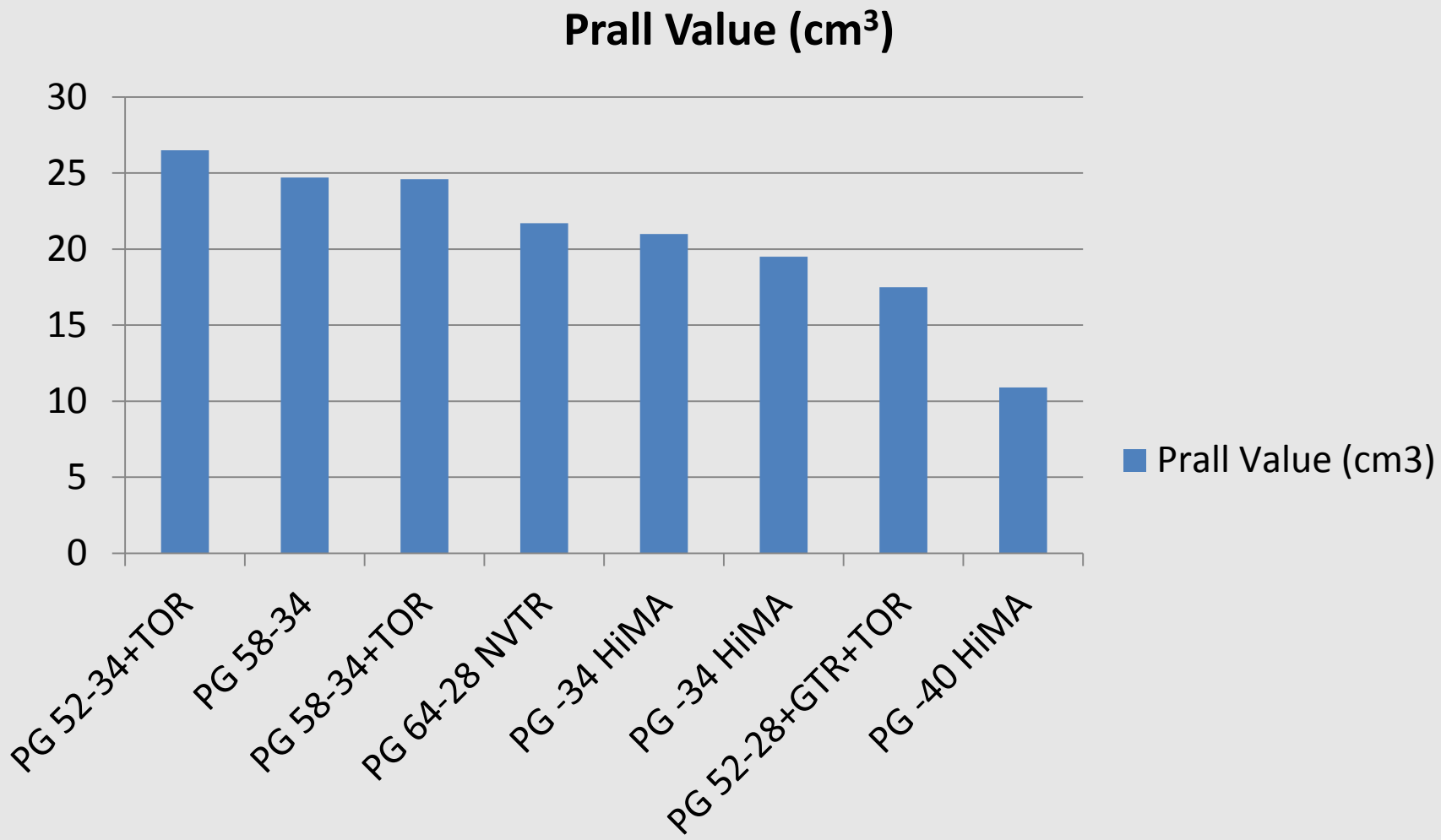
2014 – Anchorage, AK city streets to mitigate studded tire damage.

2015-16 – Wasilla, AK – Parks Highway MP 35-40 and Glenn Highway – Parks Highway interchange ramps.

2015 – Utah Castle County SR 191 – joint HiMA and fiber project to mitigate reflective cracking.

Interest in Colorado, Nevada, New Mexico and North & South Dakota

AK DOT Prall Testing for Studded Tire Wear Resistance



Prall Test Specimens

APA Rutting Test Specimen

AK DOT Specification for HiMA for Studded Tire Wear Resistance

Special Provision Section 702

702-2.01 ASPHALT CEMENTS. Meet AASHTO M 320 and the following:

PG 64-40 and shall meet AASHTO MP 19 (now AASHTO M 332) PG 64E-40

PAV DSR shall not exceed 5000 kPa @ 0°C.

Table 401-1 Class A Type 1	
Stability, pounds	1800 min.
Flow, 0.01 in	8-14
Voids in Total Mix	3-5%
Compaction blows	75
VFA	65-75%
Dust/AC	0.6-1.4
VMA	12% min.

Anchorage 5th and 6th Avenue Resurfacing
L Street to Ingra Street Project No. 59763

10,000 – 15,000 ADT
2” Mill & Fill
Hard aggregate
Paving temp 310°F
Static rolling (!)
Average densities:
Mat – 95%
Joints – 93%

PMA Producer's Perspective

- Polymer Handling
- Blending
- Storage & Pumping
- Transport

LEGAL DISCLAIMER

For more information, please call 1-800-4-KRATON, or e-mail info@kraton.com

Kraton Performance Polymers, Inc. believes the information set forth herein to be true and accurate, but any recommendations, presentations, statements or suggestions that may be made are without any warranty or guarantee whatsoever, and shall establish no legal duty on the part of any Kraton Polymers affiliated entity. **The legal responsibilities of any Kraton Polymers affiliate with respect to the products described herein are limited to those set forth in Kraton's conditions of sale or any effective sales contract. Kraton does not warrant that the products described herein are suitable for any particular uses, including, without limitation, cosmetics and/or medical uses. Persons using the products must rely on their own independent technical and legal judgment, and must conduct their own studies, registrations, and other related activities, to establish the safety and efficacy of their end products incorporating any Kraton products for any application.** Nothing set forth herein shall be construed as a recommendation to use any Kraton product in any specific application or in conflict with any existing patent rights. Kraton reserves the right to withdraw any product from commercial availability and to make any changes to any existing commercial or developmental polymer. **Kraton expressly disclaims, on behalf of all Kraton affiliates, any and all liability for any damages or injuries arising out of any activities relating to the use of any information set forth in this publication, or the use of any Kraton products.**

This publication includes "forward-looking statements," which are statements other than statements of historical fact and are often characterized by the use of words such as "believes," "expects," "estimates," "projects," "may," "will," "intends," "plans" or "anticipates," or by discussions of strategy, plans or intentions. All forward-looking statements in this publication are made based on management's current expectations and estimates, which involve risks, uncertainties and other factors that could cause results to differ materially from those expressed in forward-looking statements. These risks and uncertainties are more fully described in "Part I. Item 1A. Risk Factors" contained in our Annual Report on 10-K, as filed with the Securities and Exchange Commission and as subsequently updated in our Quarterly Reports on Form 10-Q. We hereby make reference to all such filings for all purposes. Readers are cautioned not to place undue reliance on forward-looking statements. We assume no obligation to update such information.

Kraton, the Kraton logo and design, the Cariflex logo, Cariflex, Nexar and the Giving Innovators Their Edge tagline and, in some cases, their expression in other languages, are trademarks of Kraton Performance Polymers, Inc. and are registered in many countries throughout the world.

©2015 Kraton Performance Polymers, Inc. All rights reserved.