

Highly Modified Asphalt (HiMA) Case Studies

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FHWA is the source of all images in this presentation unless noted.



U.S. Department of Transportation
Federal Highway Administration



Abbreviations and Acronyms

- APA = Asphalt pavement analyzer
- ARGG = Asphalt rubber gap graded
- CAM = Crack attenuating mixture
- EDC = Every Day Counts
- FWD = Falling weight deflectometer
- G_{mm} = Maximum theoretical specific gravity
- HiMA = Highly modified asphalt
- HPTO = High performance thin overlay
- IRI = International Roughness Index
- kPa = kilopascal
- MSCR = Multiple stress creep recovery
- NCAT = National Center for Asphalt Technology
- NMAS = Nominal maximum aggregate size
- OGFC = Open graded friction course
- QPL = Qualified products lists
- R&B = Ring and ball
- S-curve = Stiffness curve
- SBS = Styrene-butadiene-styrene
- SMA = Stone matrix asphalt
- TOPS = Targeted Overlay Pavement Solutions
- UTBWC = Ultra-thin bonded wearing course
- VFA = Voids filled with asphalt
- VMA = Voids in the mineral aggregate



TOPS

Targeted Overlay Pavement Solutions

A solution for extending the life of an existing pavement investment.

Except for any statutes or regulations cited, the contents of this presentation do not have the force and effect of law and are not meant to bind the public in any way. This presentation is intended only to provide information to the public regarding existing requirements under the law or agency policies.



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Every Day Counts
Innovation for a Nation
on the Move

TOPS EDC Mission



Image source: iStock

Extend pavement life, increase load-carrying capacity, and improve safety, mobility, and user satisfaction in a cost-effective and sustainable manner by delivering targeted pavement overlay solutions to Federal, State, and local transportation agencies.

What's in the TOPS toolbox?

Asphalt overlay products:

• High-Performance Thin Overlay (HPTO)	11 states
• Crack Attenuating Mixture (CAM)	7 states
• Highly Modified Asphalt (HiMA)	10 states
• Enhanced friction overlay	7 states
• Stone matrix asphalt (SMA)	5 states
• Asphalt Rubber Gap-Graded (ARGG)	4 states
• Open-Graded Friction Course (OGFC)	3 states
• Ultra-thin bonded wearing course (UTBWC)	3 states

EDC-6 TOPS

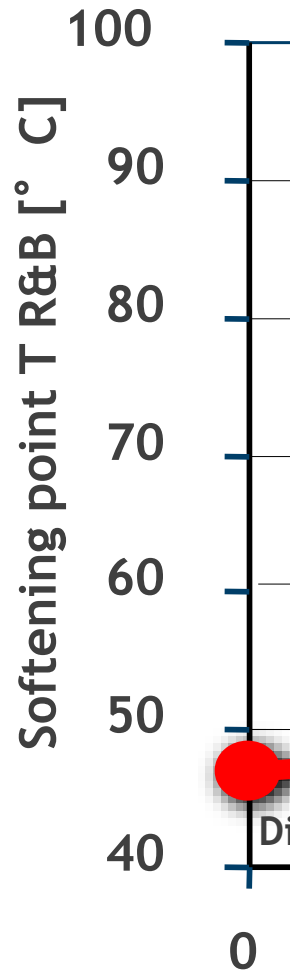
HiMA Case Studies

- HiMA is compatible with:
 - HiMA dense-graded thin overlay
 - Standard Superpave design
 - High performance thin overlay (HPTO) mixtures (dense-graded)
 - Wearing course
 - Uses mixture performance testing
 - Stone matrix asphalt (SMA)
 - Crack attenuating mixtures (CAM)
 - Interlayer
 - Uses mixture performance testing
 - Open-Graded Friction Course (OGFC)

Highly Modified Asphalt (HiMA):

- Contains more than 2 times the polymer content of traditional modified grades
- Develops a strong elastomer network-the binder behaves more like an asphalt-extended polymer than a polymer-modified asphalt binder
- Key specification parameters:
 - minimum 90% MSCR recovery
 - maximum 0.1 kPa^{-1} at elevated temperatures
 - typically, 12°C higher than pavement high temperature

“S-Cur



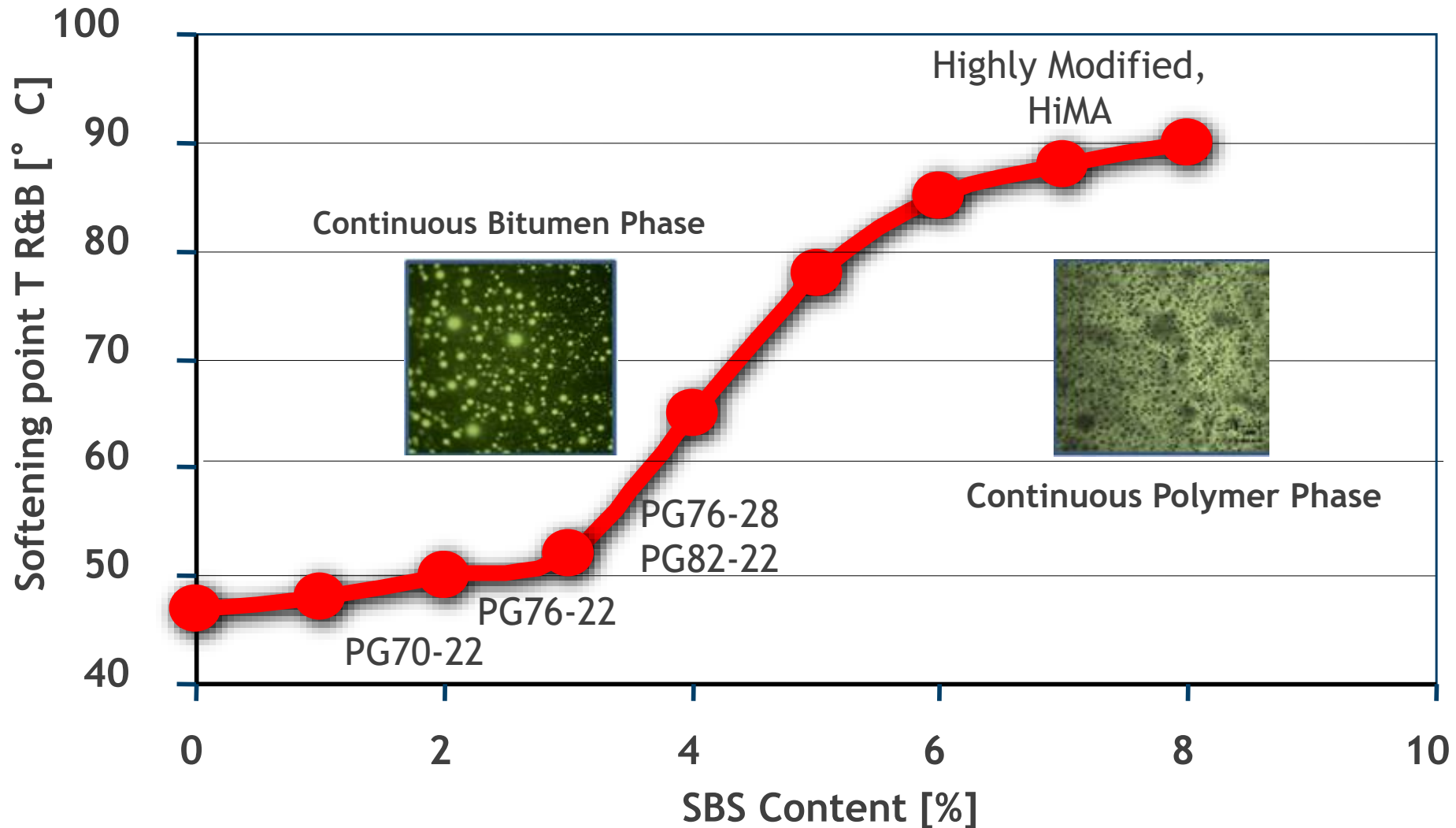
Content

Phase

Source: Kraton

10

“S-Curve” – Increasing SBS Content



Source: Kraton

Florida DOT HiMA

- FDOT's premium binder to address severe rutting, bottom-up fatigue (alligator) cracking, and raveling (OGFC)
- Replaced PG 82-22 binder in the July 2017 Specification Workbook

Florida DOT High Performance Thin Overlay (HPTO)

US-90 @ I-10 (Midway)

- Extends from I-10 interchange to beyond the truck stop entrance
- Channelized truck traffic, stopping and turning into truck stop
- Planned to reconstruct with concrete pavement
- 2015 stop gap:
 - Milled and replaced with 2.5 inches of HPTO (with HiMA)

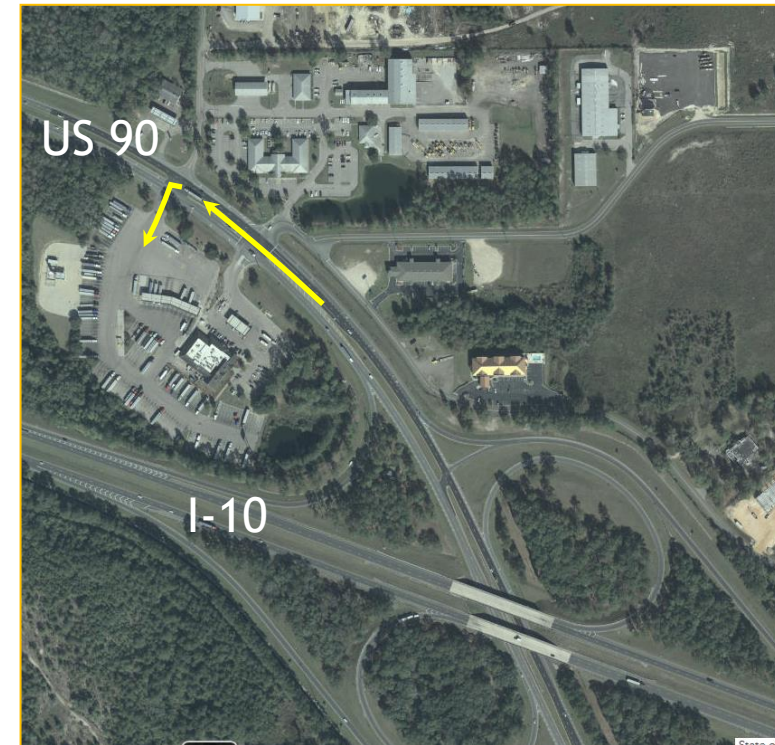
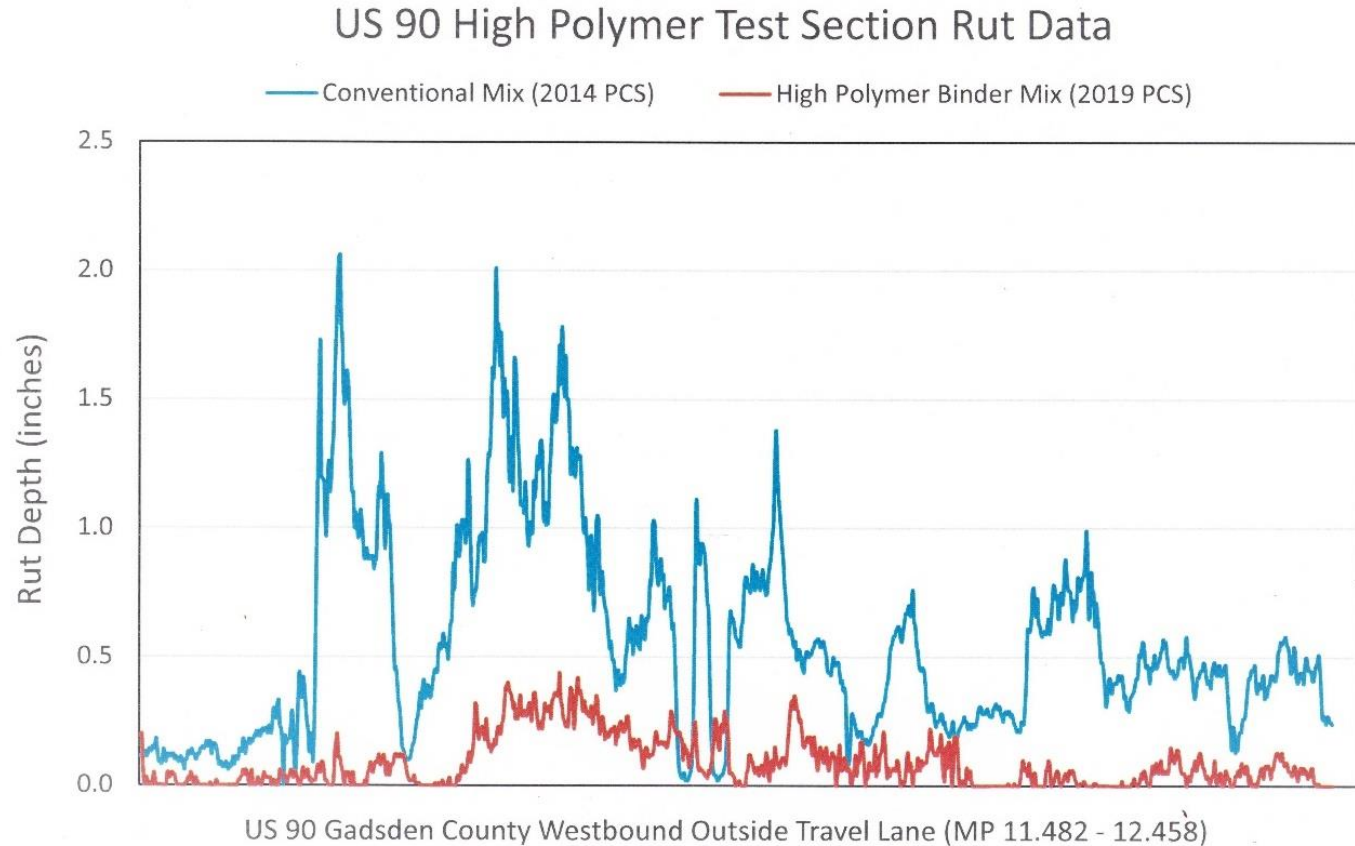


Image Source: Florida DOT

Florida DOT High Performance Thin Overlay (HPTO)

Florida DOT
Rutting Measurements on
US-90 @ I-10 (Midway)



Source: Florida DOT

Florida DOT High Performance Thin Overlay (HPTO)



Looking east at turning traffic



Stop bar at traffic signal, July 2021

US 90 @ I-10, Midway

Image Source: Florida DOT

Florida DOT HiMA Projects

- Completed 30+ projects with HiMA
- Placed over 500,000 tons of HiMA mix in Florida
- Usage is growing
- 8 asphalt terminals on QPL



Image Source: Florida DOT



Image Source: Florida DOT

New Jersey DOT High Performance Thin Overlay (HPTO)

- Reliable treatment for highways

Table 902.08.02-2 Volumetric Requirements for Design and Control of HPTO

	Required Density (% of Max Sp. Gr.)		Voids in Mineral Aggregate (VMA)	Dust-to-Binder Ratio	Draindown AASHTO T 305
	@ N _{des} (50 gyrations)	@ N _{max} (100 gyrations)			
Design Requirements	96.5	≤ 99.0	≥ 18.0 %	0.6 – 1.2	≤ 0.1 %
Control Requirements	95.5 - 97.5	≤ 99.0	≥ 18.0 %	0.6 – 1.3	≤ 0.1 %

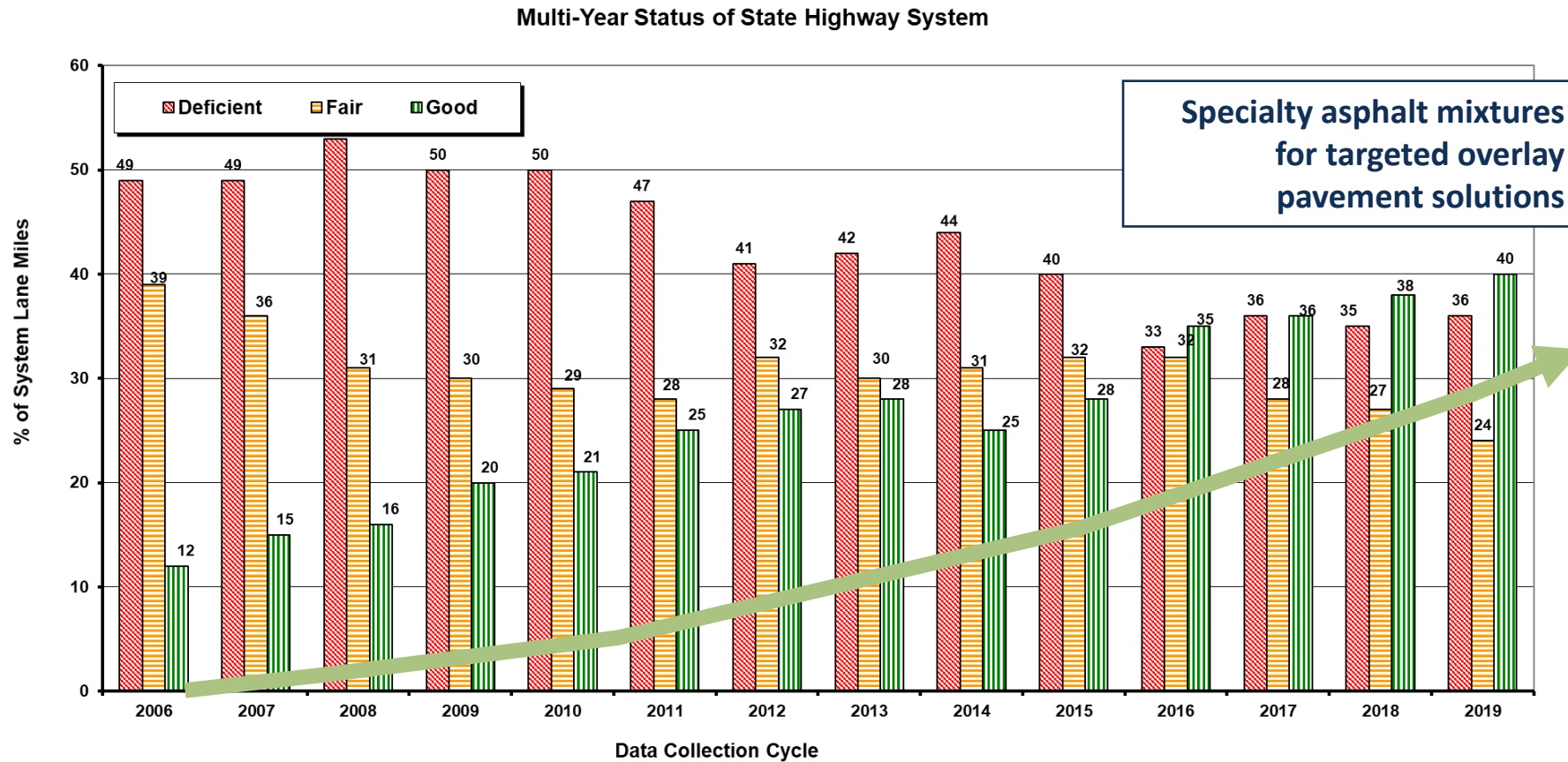
Table 902.08.03-1 Performance Testing Pay Adjustments for HPTO

Test	Requirement	Test Result	PPA
APA @ 8,000 loading cycles, mm (AASHTO T 340)	5.0 maximum	$t \leq 5.0$	0
		$5.0 < t \leq 12.0$	$-50(t-5)/7$
		$t > 12.0$	-100 or Remove & Replace
Overlay Tester, cycles (NJDOT B-10)	600 minimum	$t \geq 600$	0
		$600 > t \geq 400$	$-(600-t)/4$
		$t < 400$	-100 or Remove & Replace

Source: New Jersey DOT

The “Why” & Potential Benefits

NJDOT Benefits: Overall Pavement Network Improvements



Source: NJDOT Pavement Management System

New York City DOT High Performance Thin Overlay (HPTO)



1st Ave, New York City, 2013



1st Ave, New York City, April 2019

- NYC DOT typically resurfaces major arterial streets every 2 years
- HPTO (with HiMA) still in place, performing well after 7 years

Image Source: Frank Fee

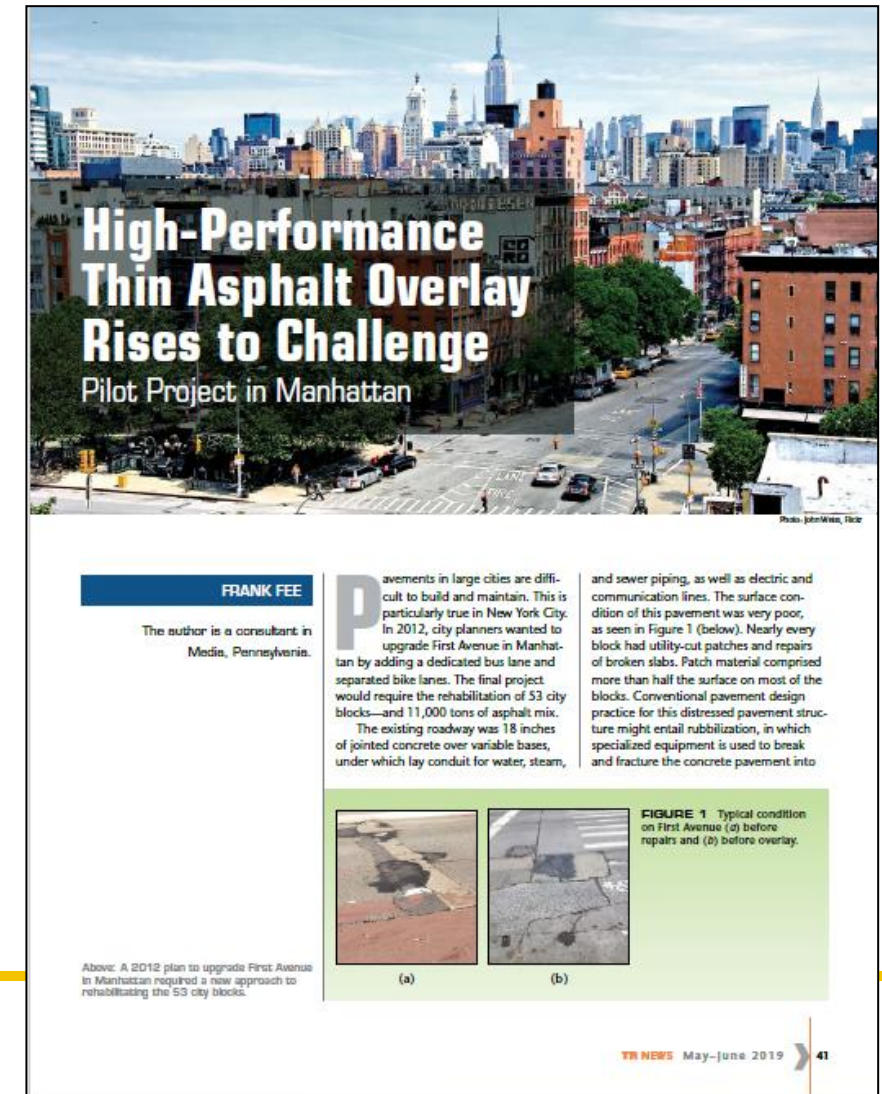
New York City DOT High Performance Thin Overlay (HPTO)

- 2013
 - 1st Avenue, Manhattan
 - 72nd Street to 125th
- Remains in good condition, according to NYC DOT website

Source: TRNews, May/June 2019, page 158:

<https://www.trb.org/Publications/Blurbs/179900.aspx>

<https://www.scribd.com/document/192569722/Sustainable-Streets-2013-and-Beyond-NYC-DOT>



Virginia DOT Dense (9.5 & 12.5mm) and Stone Matrix Asphalt (SMA)

- PG 76E-28 (HiMA)
- Application:
 - On Interstates (I-95, I-495) and other high-volume roadways
 - Over jointed concrete pavements and cracked asphalt pavements
- Quantity of HiMA since 2014
 - 16 projects
 - 205,000 tons
- Source:
<http://vtrc.virginiadot.org/PubDetails.aspx?PubNo=21-R16>

Virginia DOT Dense (9.5 & 12.5mm) and Stone Matrix Asphalt (SMA)

- Performance
 - Reduced rate of reflection cracking (over deteriorated pavements)
 - 34% life extension compared to conventional binder grades
- Source:
<http://vtrc.viriniadot.org/PubDetails.aspx?PubNo=21-R16>



Virginia DOT Survey

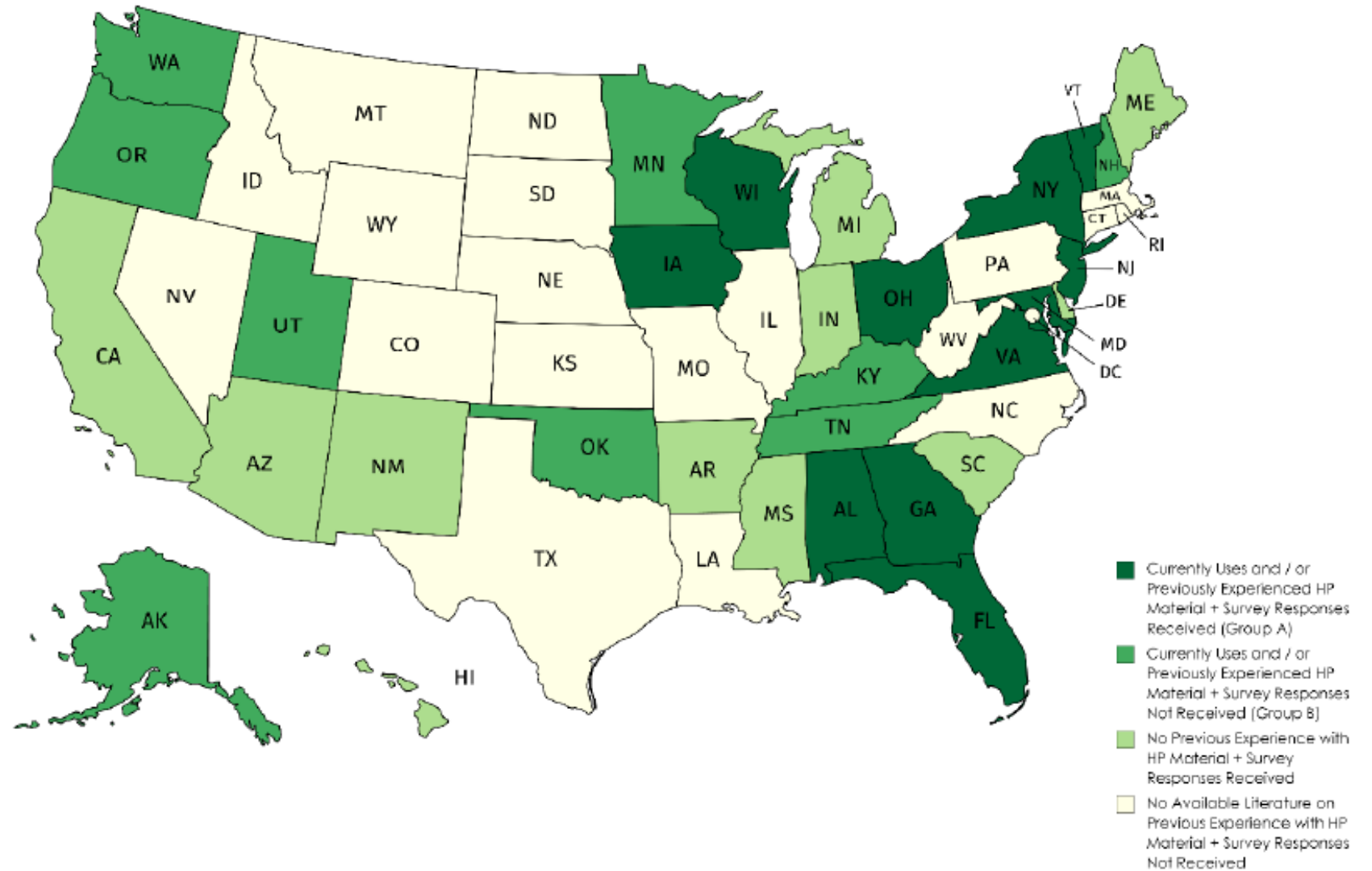


Figure 2. U.S. Map Indicating Agencies' Experience Status with HP AC Mixtures

Source: <http://vtrc.virginiadot.org/PubDetails.aspx?PubNo=21-R16>

Oklahoma DOT Crack Attenuating Mixtures (CAM)

- NCAT Test Track in 2012 as part of rehab strategy for a failed Oklahoma test section
 - 1½ inch lift, low air voids design
 - CAM with PG 76-28E (HiMA)
- Success led to ODOT using a similar approach on a problematic section of I-40 about 50 miles west of OKC
 - Two-mile long section built in 2012
 - Minimal cracking and rutting, 2021 IRI < 50 in/mi
- Now alternative to fabric interlayer & leveling course
 - Rural county roads to Interstate highways



Image Source: Oklahoma DOT

Oklahoma DOT Crack Attenuating Mixtures (CAM)

- Specifications:
- Laboratory Mix Design Properties:
 - S5 gradation (9.5 mm NMAS)
 - PG 76E-28 binder grade (HiMA)
 - Binder content $\geq 5.5\%$
 - $N_{des} = 50$ gyrations, 97% G_{mm} , VMA $\geq 15.5\%$, VFA: 73-79%
 - Hamburg: ≤ 12.5 mm after 20,000 passes

Oklahoma DOT Crack Attenuating Mixtures (CAM)

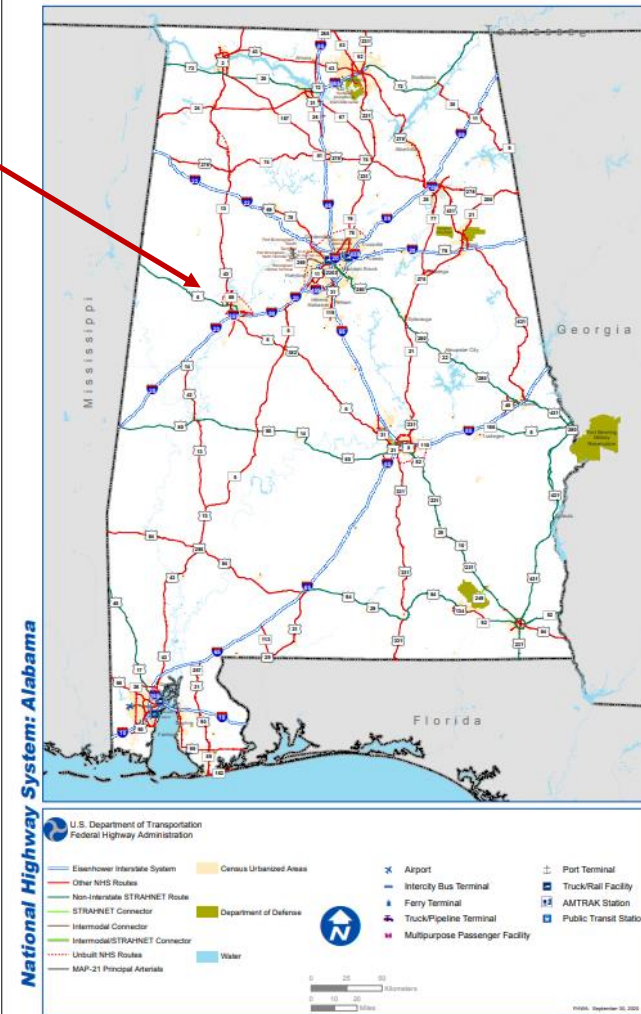
Cost Comparison: CAM vs. Fabric

- Using data from Oklahoma Department of Transportation, Price History From January 1, 2019, to June 30, 2020
- For head-to-head cost comparison, must include cost of a leveling course with fabric interlayer to provide the same end result

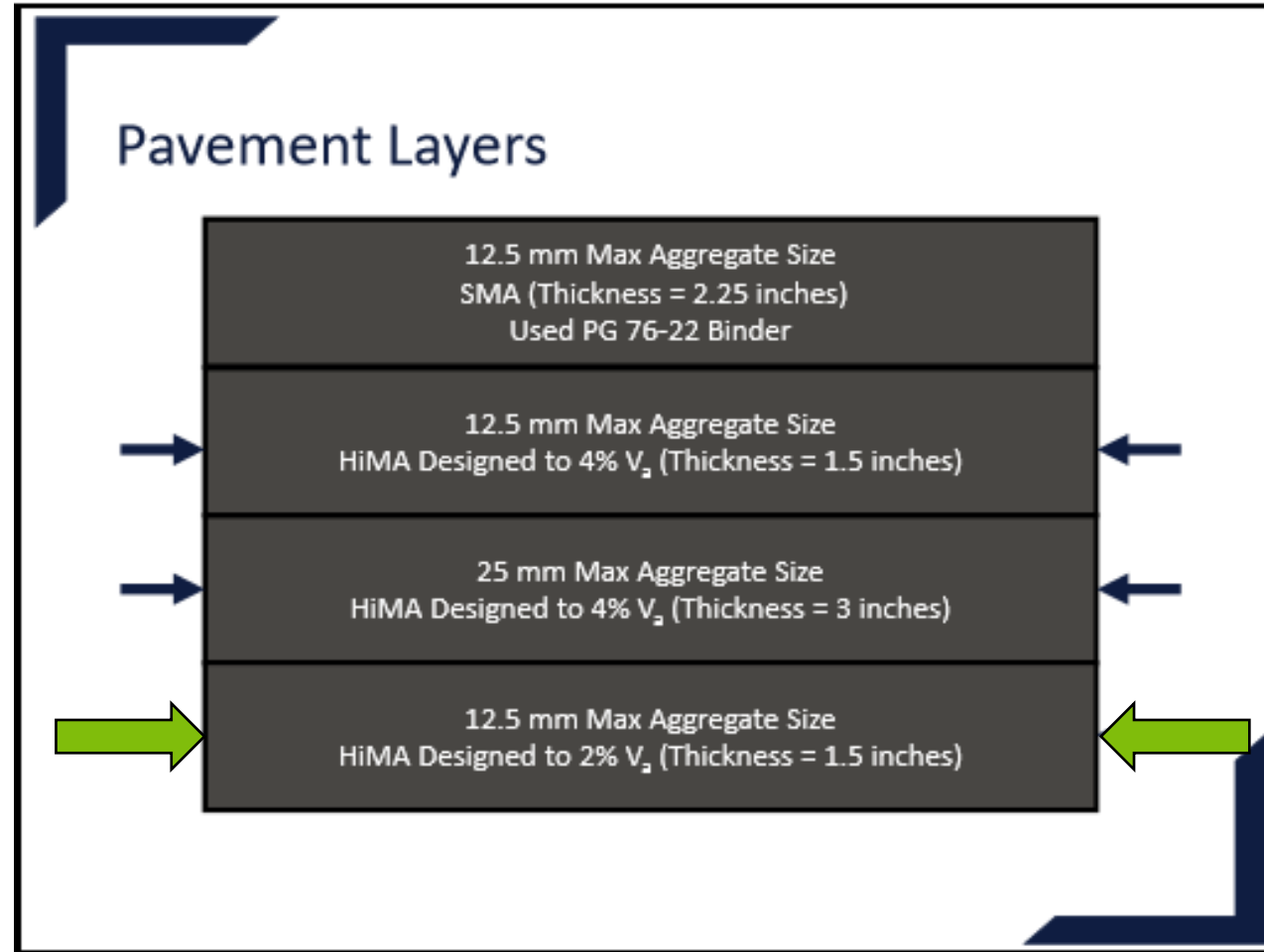
Item	Fabric Interlayer	CAM
S411, CAM (1.25") (\$108.24/ton)	---	\$7.44/sy
S409, Fabric	\$1.78/sy	---
S409, Bit. Binder	\$0.67/sy	---
S411 Leveling (S5) (\$90/ton)	\$6.19/sy	---
Totals	\$8.64/sy	\$7.44/sy

Alabama DOT Crack Attenuating Mixture (CAM)

- I-59/20, Tuscaloosa, AL
 - MP 62.0-68.4
- Opened in 1970
 - rehabilitated in 1983, 1990 and 2001
- Extensive longitudinal cracking
 - About 1/3 of cracks extended beyond the top 4 inches of pavement
 - FWD analysis suggested the need for additional pavement thickness
- Numerous bridges within project limits complicated things
 - Very costly to raise bridges to allow for additional structure
 - Estimated almost \$8.7 million just to raise bridge surfaces
- Rehabilitation using HiMA completed in 2016, performing well



Alabama DOT Crack Attenuating Mixture (CAM)



Source: Braden Smith (Hunt Refining) at 2018 SEAUPG Meeting

Alaska DOT & PF

Resistance to Studded Tire Wear

- PG 64E-40 has been shown to provide better resistance to mechanical wear in the lab and the field

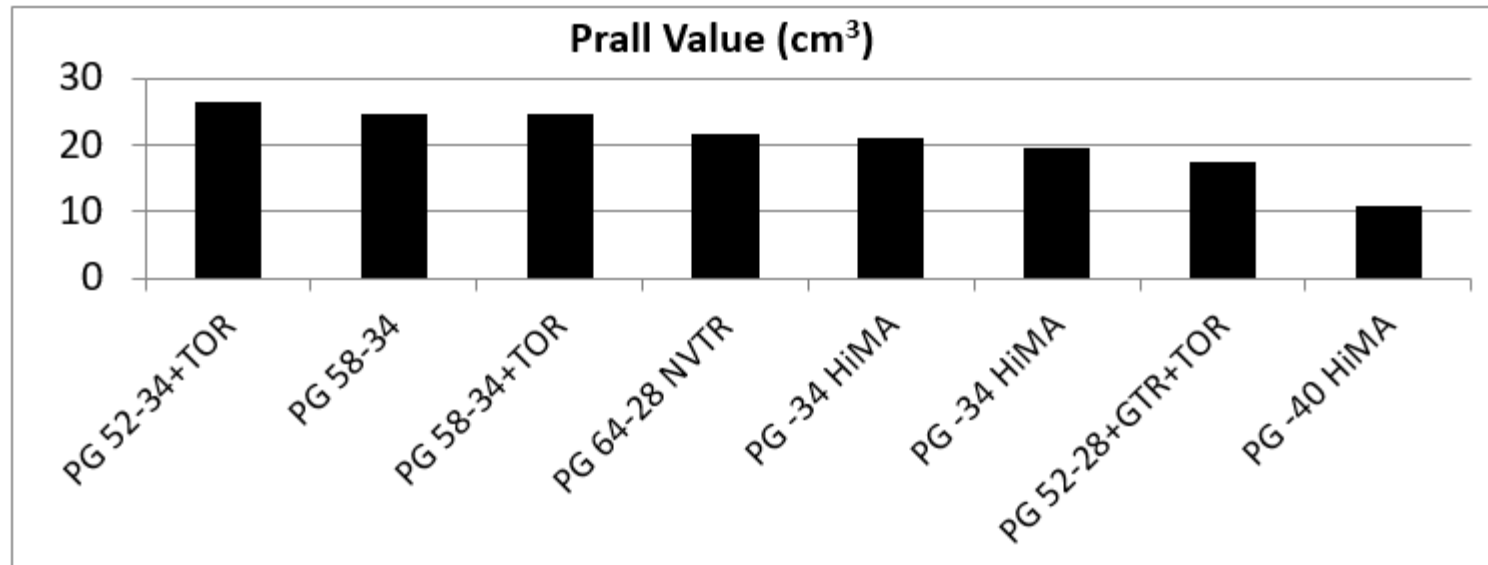


Figure 7. Prall Test Results for a Range of Binders

Source: "A Novel Approach to Mitigating Studded Tire Abrasion," CTAA 2016, Burditt, Kluttz and Lubbers

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HiMA Case Studies

- Thin overlay with HiMA
- HiMA is compatible with:
 - High performance thin overlay (HPTO) mixtures (dense-graded)
 - Wearing course
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