Image source: NAPA

Image source: ACPA

U.S. Department of Transportation
Federal Highway Administration

TOPS

Targeted Overlay Pavement Solutions

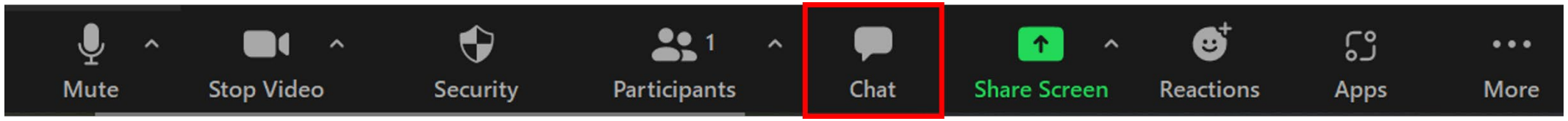
A solution for extending the life of an existing pavement investment.

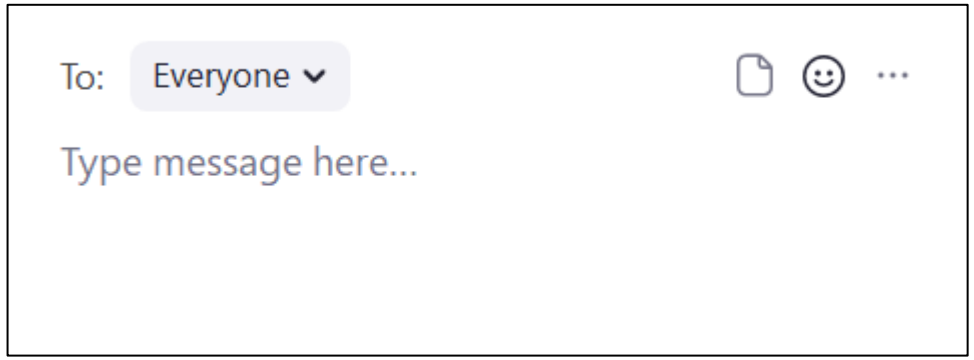
Except for any statutes or regulations cited, the contents of this webinar do not have the force and effect of law and are not meant to bind the public in any way. This webinar is intended only to provide information to the public regarding existing requirements under the law or agency policies.

Every Day Counts
Innovation for a Nation on the Move

Submitting Questions

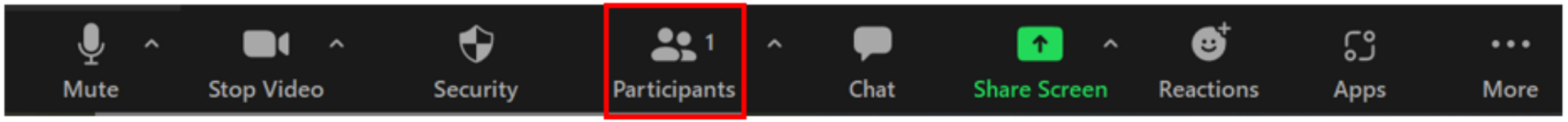
- To ask a question, send a message using the chat function.
- All questions from participants will be answered during the Q&A session at the end of the webinar.



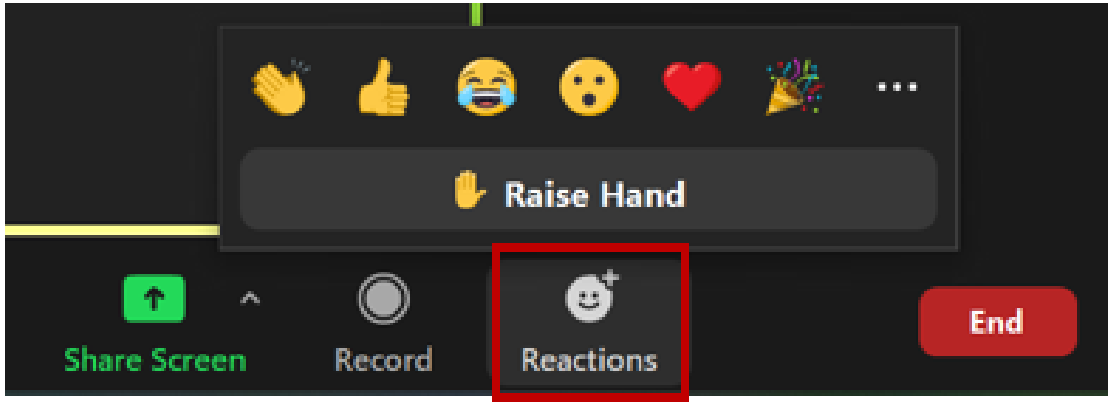


Zoom Features

- To view a list of meeting participants, click the Participants button in the bottom panel.

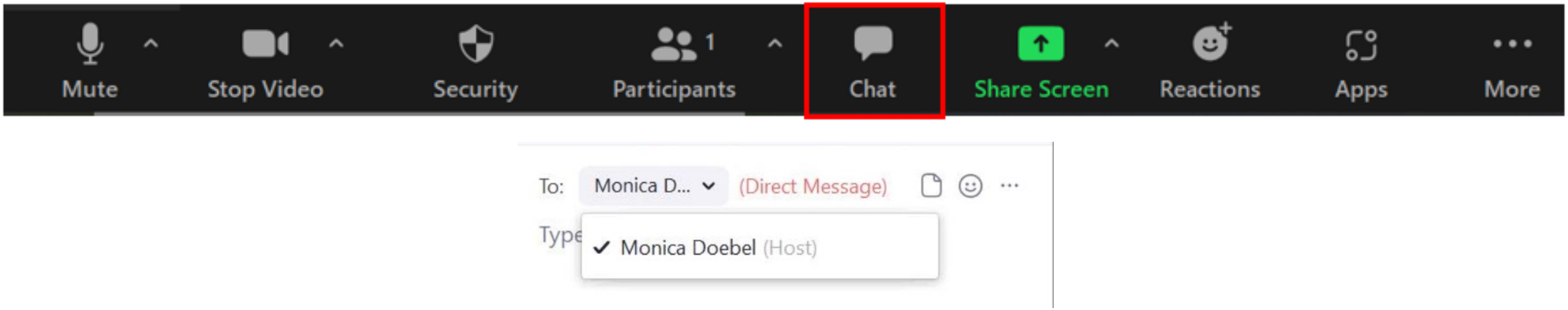


- To send reactions, click the Reactions button.



Technical Difficulties?

- If you experience any technical issues, please reach out using one of the following methods:
  - Send a direct message to the meeting hosts.



  - Email monica.doebel@weris-inc.com and eric.schulman@weris-inc.com.

Webinar Overview

- Introduction to EDC-6 TOPS: Tim Aschenbrener, FHWA
- SMA Overview
- SMA Agency Experience: Sheila Hines, GDOT Consultant
- HiMA Overview
- HiMA Agency Experience: Howie Moseley, FDOT
- SMA/HiMA Q & A

FHWA TOPS EDC-6 Team

Tim Aschenbrener
FHWA Headquarters

Bob Conway
FHWA Resource Center

Derek Nener-Plante
FHWA Resource Center

Background

- Over 25% of all State DOT infrastructure funds go to pavements overlays.
- State DOT manage 2.8 million miles of pavements.

- *Information source: FHWA at https://www.fhwa.dot.gov/innovation/everydaycounts/edc_6/targeted_overlay_pavement.cfm*

Image source: Iowa State University

How is this different from typical overlays?

TOPS matches treatments to high-priority, high-need locations.

Image source: Georgia DOT

TOPS EDC Mission

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.

EDC-6 Goals

- Increase the number of participating agencies that demonstrate, assess, or institutionalize an additional TOPS technology not previously institutionalized.
- Build awareness and expand TOPS usage
  - Identify a champion at each State agency
  - Share information at conferences/workshops
  - Train people (webinars/peer exchanges)

What's in the TOPS toolbox? (1 of 2)

Asphalt overlay products:

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

What's in the TOPS toolbox? (2 of 2)

Concrete overlay products:

- Concrete on Asphalt – Bonded (COA-B)
- Concrete on Asphalt – Unbonded (COA-U)
- Concrete on Concrete – Bonded (COC-B)
- Concrete on Concrete – Unbonded (COC-U)

TOPS Potential Benefits

- Improved Safety
- Improved Performance
- Retained Investments
- Cost Savings
- Environmentally Sound

U.S. Department of Transportation
Federal Highway Administration

TOPS
Targeted Overlay Pavement Solutions

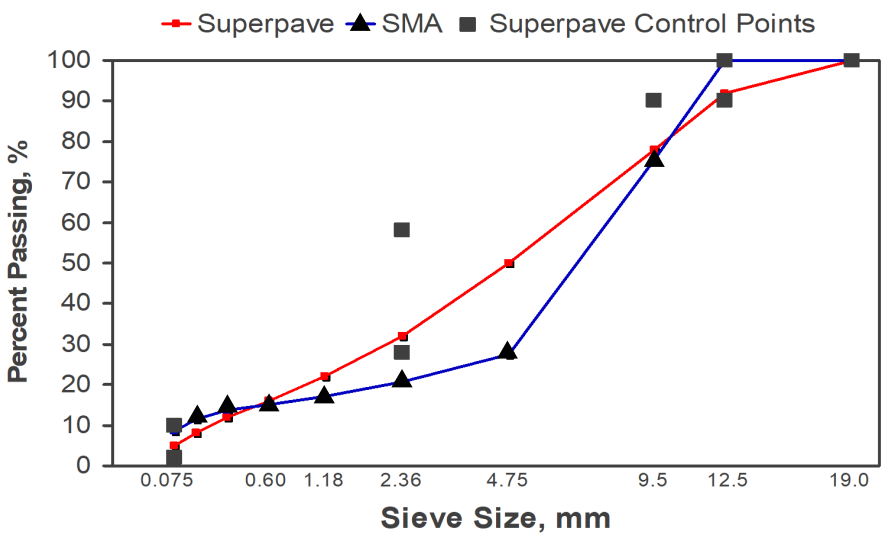
Stone Matrix Asphalt (SMA)

Every Day Counts
Innovation for a Nation on the Move

SMA Background

- What is SMA?
  - Gap-graded asphalt mixture
  - Maximizes rutting resistance and durability
    - Stone-on-stone contact
    - High asphalt binder mortar
- Developed in Germany in 1960s
- Introduced to U.S. in 1990
  - Partnership of industry, government, and research
  - Placed in heavy traffic areas

SMA Aggregate Structure



Source: NCAT

SMA Applications

- Heavy traffic routes
  - Interstate routes
  - High traffic state routes
- High-stress pavement areas
  - Intersections
  - Toll booths
  - Bus stops
  - Airfields

Heavy Traffic Application

Source: Shutterstock

Project Selection Criteria

- Alabama and Maryland
  - Projects with 20-year design traffic greater than 30 million equivalent single axle loads(ESALs)
  - Projects where rutting is a concern
- Wisconsin
  - Projects with 20-year design traffic greater than 5 million ESALs
    Projects where low maintenance is beneficial
- Georgia
  - All interstates
  - State routes with greater than 50,000 average annual daily traffic

SMA Benefits

- Extended pavement life
- Reduced potential for rutting
- Retards reflective cracking on concrete pavement overlays
- Noise reduction
- Improved visibility of wet pavements

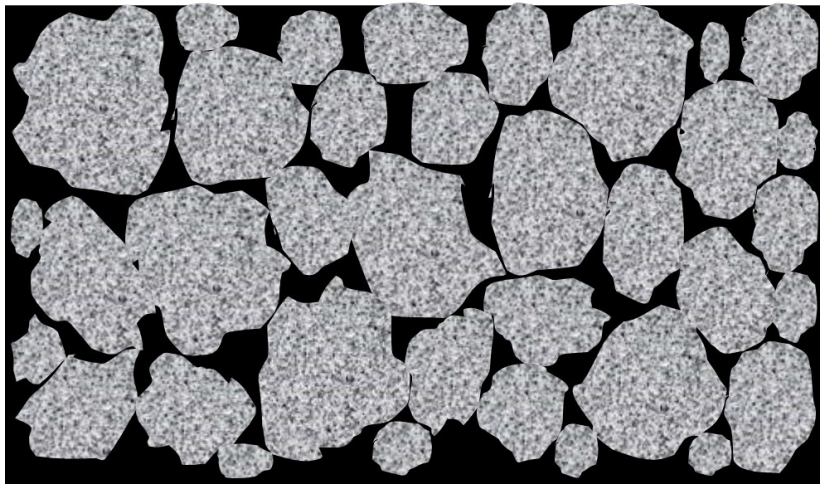
Conventional Asphalt Mix vs. SMA

Source: NCAT

Composition of SMA

- High quality aggregate
  - L.A. abrasion- 30% loss maximum
  - Design for stone-on-stone contact
  - Fine aggregate angularity- 45% minimum
- Rich binder mortar
  - High asphalt content- approximately 25% thicker asphalt film than conventional mix
  - Modified binder
  - Mineral filler
  - Stabilizing additives

Stone-on-Stone Contact



Source: NCAT

Typical Mix Design

- Mix design
  - Select Materials
  - Gradation
  - Vca testing
  - Compaction- Method and rate varies by agency
  - VMA- 17% minimum
  - Optimum AC at 3-4% air voids

Performance Testing

- Draindown
- Moisture susceptibility
- Rutting

Draindown Testing

Source: NCAT

SMA Production and Transportation

- Production
  - Minimize start-ups and shut-downs
  - Split primary coarse aggregate into two feeders
  - Modify silo for feeding mineral filler
  - Provide fiber dispersing machine
- Transportation
  - Use sufficient trucks to keep paving operation moving
  - Use approved truck-bed release agent

Mineral Filler Silo

Source: NCAT

SMA Construction Practices

- Placement
  - Minimize hand work
  - Keep operation moving
  - Pay attention to detail
- Compaction
  - Pneumatic rollers not recommended
  - Target 5% air voids (95% theoretical maximum density)

Keep Operation Moving

Source: Georgia DOT

GDOT Case Study

About the Presenter

Sheila Hines

- Senior Project Manager - Bituminous Construction at NOVA Engineering and Environmental, LLC
- On-site consultant for GDOT
- GDOT Bituminous Construction Engineer (2003 to 2018)
- GDOT Bituminous Technical Services Manager (1998 to 2003)
- B.S. Southern Polytechnic State University

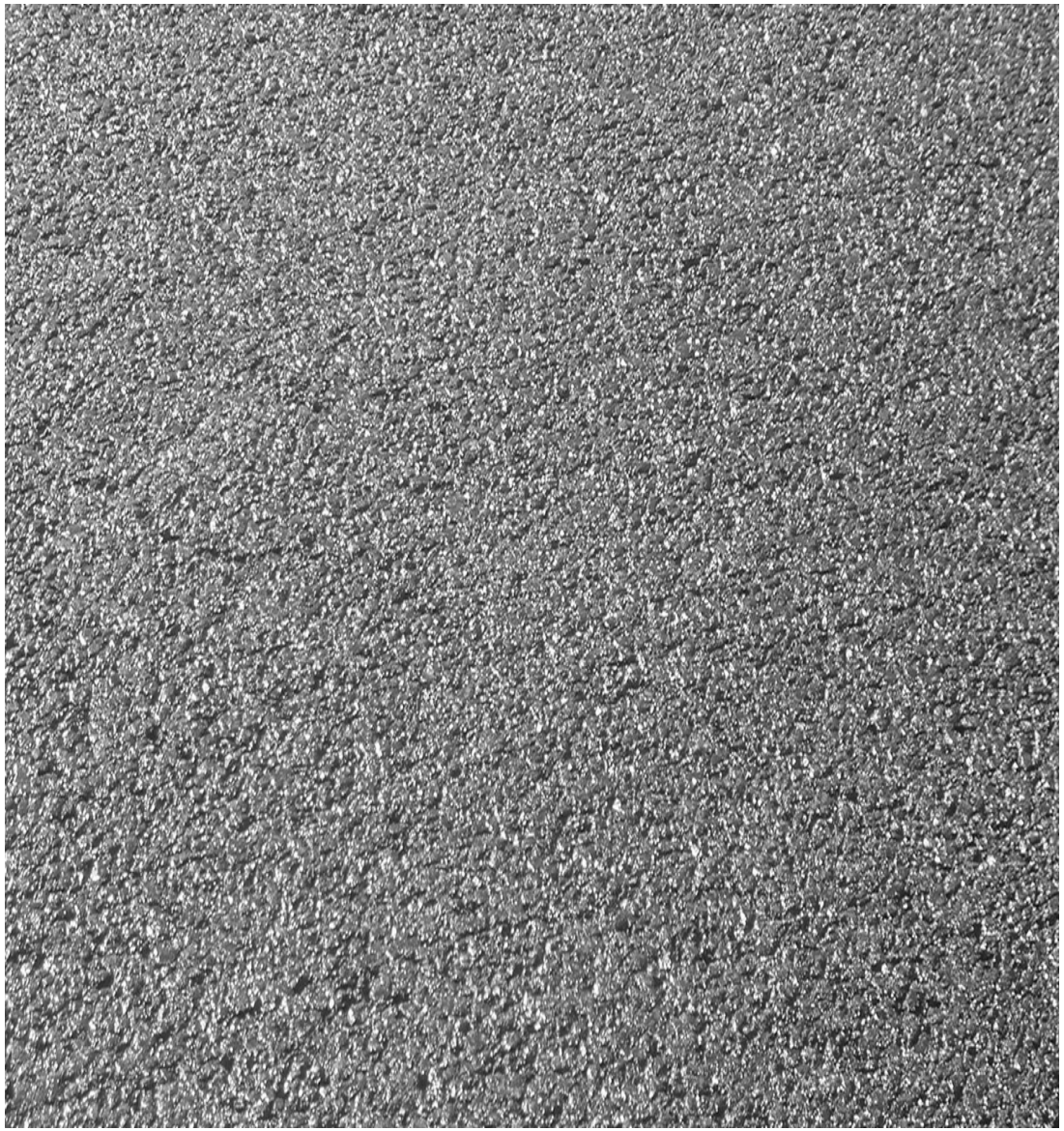
GDOT

Georgia Department of Transportation

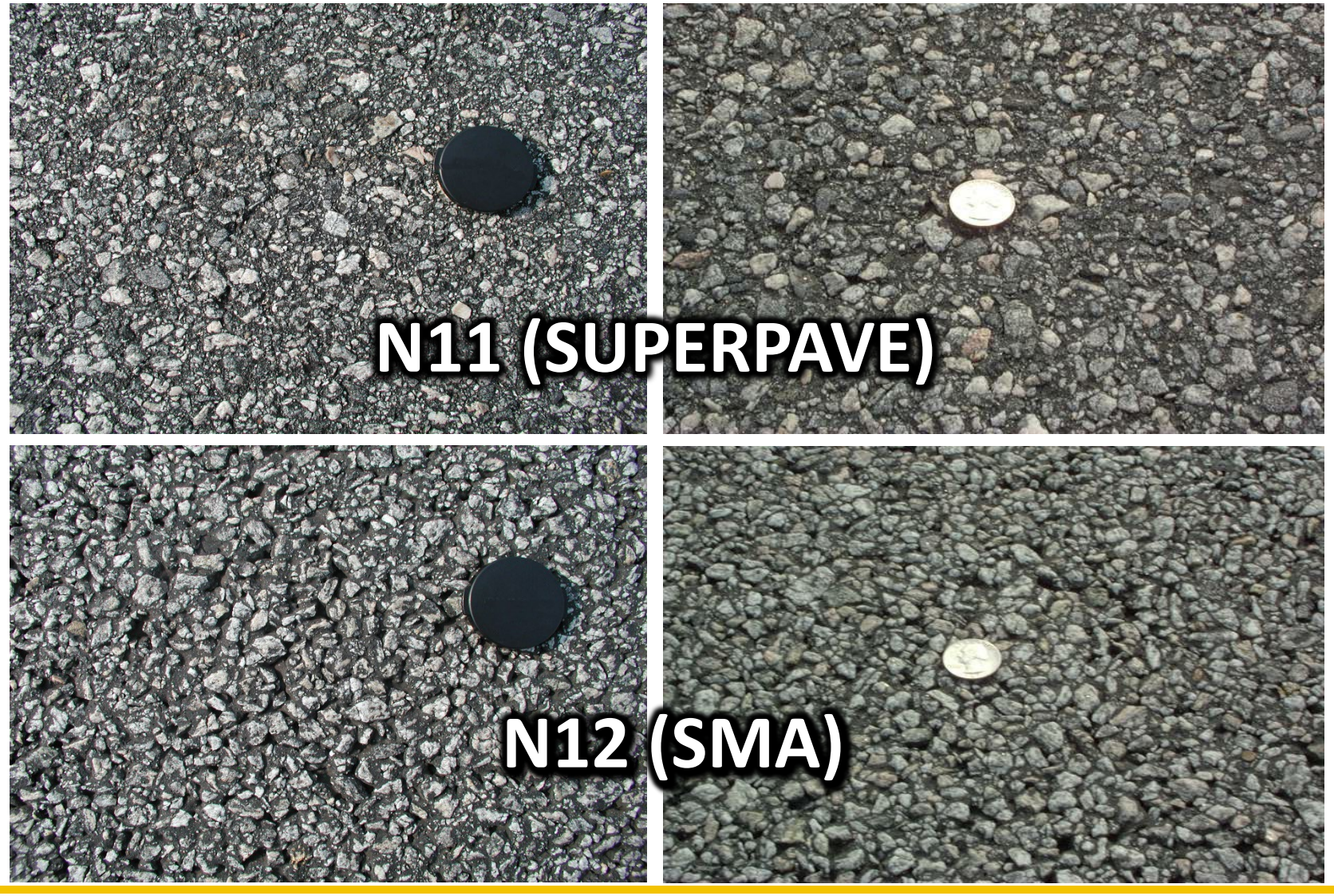
Georgia's Experience with SMA

Georgia among first states to place SMA mixture in the USA (1991) seeking

- **Improved rutting resistance**
- **Increased durability and fatigue resistance**
- **Longer service life**
- **Lower lifecycle cost**



NCAT Test Track (Georgia's Sections – 2-cycles)



More than 4.4 million tons of SMA mix have been placed in Georgia since 1991

- Georgia uses 12.5 mm SMA as a gap-graded mixture beneath OGFC on all asphalt interstates.
- 19 mm SMA has been used as the intermediate layer on several GDOT projects with excellent performance! This mix has been placed typically when overlaying PCC pavements.

Lessons Learned

- Temperature is key
- Materials feed must be accurate and consistent
- Production/placement coordination is vital
- No handwork
- No rubber tire rollers
- If the mix and temperature are right, compaction is easy

(1)

(2)

(3)

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(5)

(6)

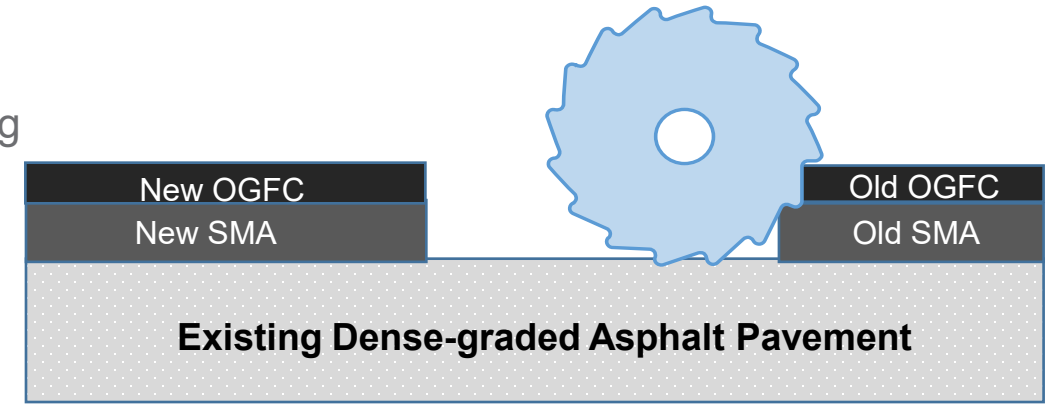
(7)

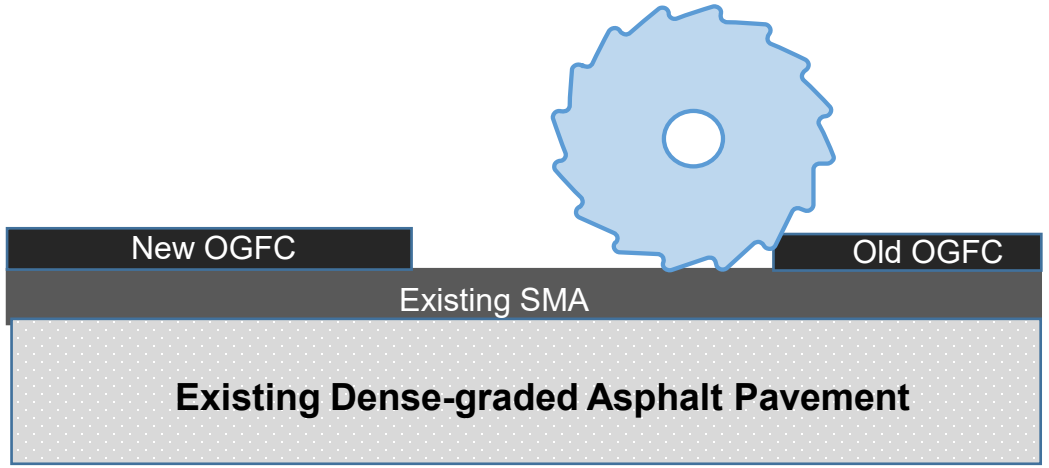
Georgia Now Places SMA with Two Life Cycles in Mind

- In 2007 and 2008, GDOT placed two test projects using micro-milling to remove and replace the deteriorating open-graded mix while maintaining the immediate underlying mix in-place.

  - I-75 (Perry, GA Dense-graded mix original 1995
    - Micro-milled 2007 (Resurfaced 2020)
  - I-95 (Savannah, GA) SMA mix original 1995
    - Micro-milled 2008 (Still in place - 2022)

Standard tool for SMA Interstate Projects with Acceptable Underlying Pavement Structure





SMA - 27 years and counting…

SMA
Always a Top Performer

U.S. Department of Transportation
Federal Highway Administration

TOPS
Targeted Overlay Pavement Solutions

Highly Modified Asphalt (HiMA)

Every Day Counts
Innovation for a Nation on the Move

HiMA Binders

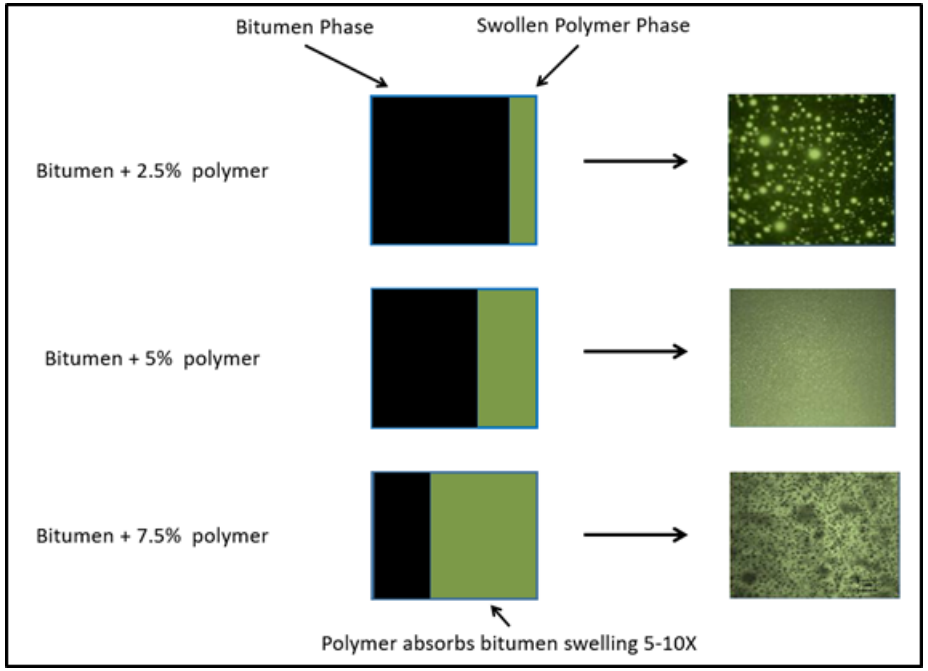
- Asphalt binder modified with 7 – 8% Styrene Butadiene Styrene (SBS) polymer
  - Conventional PMA binders contain 2 – 3% polymer
  - Polymers for HiMA binders have a slightly different chemical structure than conventional PMA polymers
- Conventionally-modified binders consist of an asphalt binder structure with a dispersed swollen polymer phase
  - HiMA binders consist of a swollen polymer structure with a dispersed asphalt phase
- HiMA binders behave more like rubber and enhances cracking resistance and rutting performance.

SBS Polymer Pellets

Source: NCAT

Effect of increasing SBS polymer content on binder/polymer morphology

Polymer Bitumen Interaction

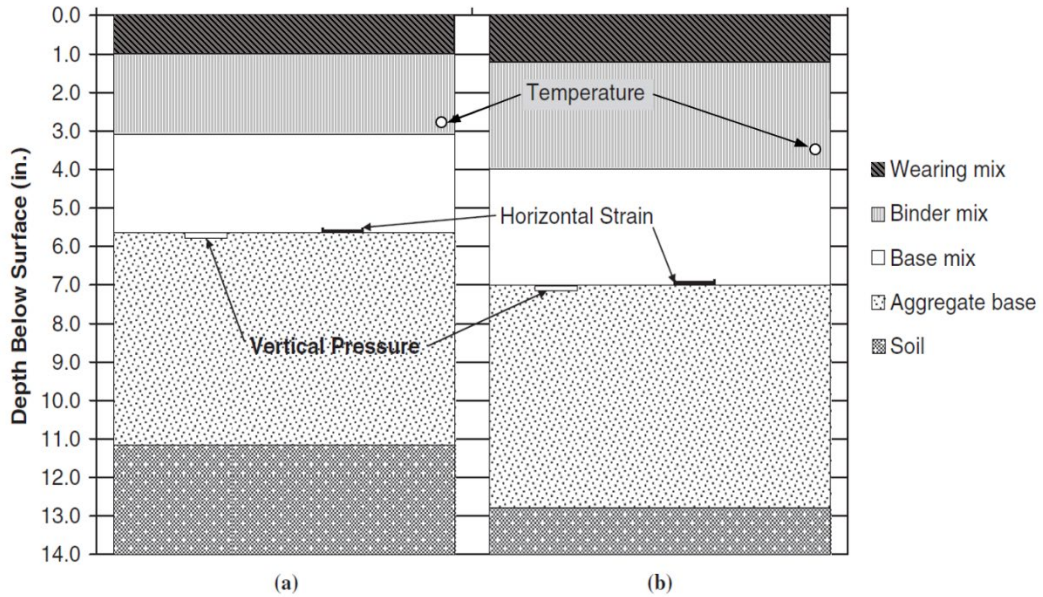


(Source: Kraton Polymers)

Benefits of High Polymer Content

- Improved rutting resistance
- Improved cracking resistance
- Potential thickness reduction

NCAT Test Track Trial Sections



Source: NCAT

After 20 million equivalent single-axle loads of trafficking, the HiMA test section had performed as well or better than the control section despite being constructed 1.25 inches thinner.*

*Willis, R., Timm, D. and Klutz, R. (2016). Performance of a High Polymer-Modified Asphalt Binder Test Section at the National Center for Asphalt Technology Pavement Test Track. Transportation Research Record, No. 2575: 1-9. https://doi.org/10.3141/2575-01.

HiMA Background

- NCAT Test Track: 2009
  - Contractor sponsored section N7
    - Thickness reduction
  - Repair of Oklahoma DOT sponsored section N8
- Georgia DOT: SR-138 & SR-155 (2010)
  - High stress intersection
- Brazil: PR-092 (2011)
  - Heavy agricultural loading
- New York City: 1st Avenue Manhattan (2011)
  - PCC replacement
- Oklahoma DOT: I-40 (2012)

NCAT Test Track

Source: NCAT

HiMA Applications

- Structural Applications
  - Potential reduced pavement thickness
  - Offset weaker base/subgrade
- Thin Overlays
- Open-Graded Mixes
  - Improved durability, reduced raveling
- SAMI Layer
- High Stress Applications
  - Intersections; weigh stations; high volume facilities

Fatigue Cracking

Source: Florida DOT

High Volume Intersection

Source: Florida DOT

Design and Planning

- Project selection criteria.
  - “Premium” mixture – more costly
  - Typically selected to target specific distresses
- Uses:
  - Thin overlay pavement preservation technique;
  - Milling and resurfacing project;
  - New construction;
  - Alternative to PCC reconstruction
- Pavement design

Thin Overlay with HiMA

Source: Travis Walbeck

Milling and Resurfacing

Source: NCAT

Materials/Mixture Properties

- Aggregates
  - State DOT requirements
- Recycled materials and additives
  - Agency decision
- Mixture design
  - State DOT requirements
- Performance requirements
  - State DOT requirements
- Specifications
  - Binder
  - Mixing and storage temperatures

Binder Specifications (AASHTO M 320)

Agency	Performance Grade	Properties
Minnesota	PG 76-34	ER ≥ 90%
New Hampshire	PG 76-34	ER ≥ 90%
Ohio	PG 88-22	ER ≥ 90%
Oregon	PG 76-28	ER ≥ 90%
New York City	PG 76-34	ER ≥ 90%
Utah	PG 76-34	ER ≥ 90%
Vermont	PG 76-34	ER ≥ 90%
Washington	PG 76-34	ER ≥ 90%

Use of the AASHTO M 320 specification is not a Federal requirement..

Binder Specifications (AASHTO M 332)

Agency	Performance Grade	Properties
Alabama	PG 76E-22	$R_{3.2} \geq 90\%$
Alaska	PG 64E-40	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 95\%$ at 64°C
Florida	PG 76E-22	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 90\%$ at 76°C
Georgia	PG 76E-22	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 90\%$ at 76°C
Iowa	PG 64E-34	$R_{3.2} \geq 90\%$ at 64°C
Kentucky	PG 76E-22	$R_{3.2} \geq 90\%$ at 76°C
Missouri	PG 76E-22	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 90\%$ at 76°C
New Jersey	PG 64E-22	$J_{nr,\ 3.2} \leq 0.3\text{-}0.5\ kPa^{-1}$ at 64°C
New York	PG 76E-28	$J_{nr,\ 3.2} \leq 0.5\ kPa^{-1}$ and $R_{3.2} \geq 55\%$ at 76°C
Oklahoma	PG 76E-28	$R_{3.2} \geq 95\%$ at 76°C
Tennessee	PG 76E-28	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 90\%$ at 76°C
Virginia	PG 76E-28	$J_{nr,\ 3.2} \leq 0.1\ kPa^{-1}$ and $R_{3.2} \geq 90\%$ at 76°C
Wisconsin	PG 58E-34	$J_{nr,\ 3.2} \leq 0.5\ kPa^{-1}$ and $R_{3.2} \geq 75\%$ at 58°C

Source: FHWA 2021

Production and Construction Practices

- Production, storage, and transportation
  - Temperature – Do not overheat
  - Mixture and Binder Storage
  - Communication with supplier
  - MTV recommended
- Surface preparation
  - Standard
- Placement and compaction
  - Follow good compaction practices
  - Pay attention to detail!

Binder Storage Tanks

Source: CRH Americas Materials

FDOT Case Study

About the Presenter

- **Howie Moseley**, Florida Department of Transportation (FDOT)
- FDOT State Bituminous Materials Engineer
- 23 years experience with FDOT
- Bachelor's and Master's Degree in Civil Engineering from the University of Florida.
- Licensed professional engineer in the State of Florida.

Florida Department of
TRANSPORTATION

FDOT's HiMA Experience

Background

- FDOT first used HiMA binder in 2015 on two demonstration projects
- HiMA binder replaced PG 82-22 in FDOT's July 2017 spec book
- It is FDOT's premium binder to address severe rutting, bottom-up fatigue (alligator) cracking, and raveling (in OGFC mixtures)
- Approximately 4 - 5% of mix placed on FDOT's system annually

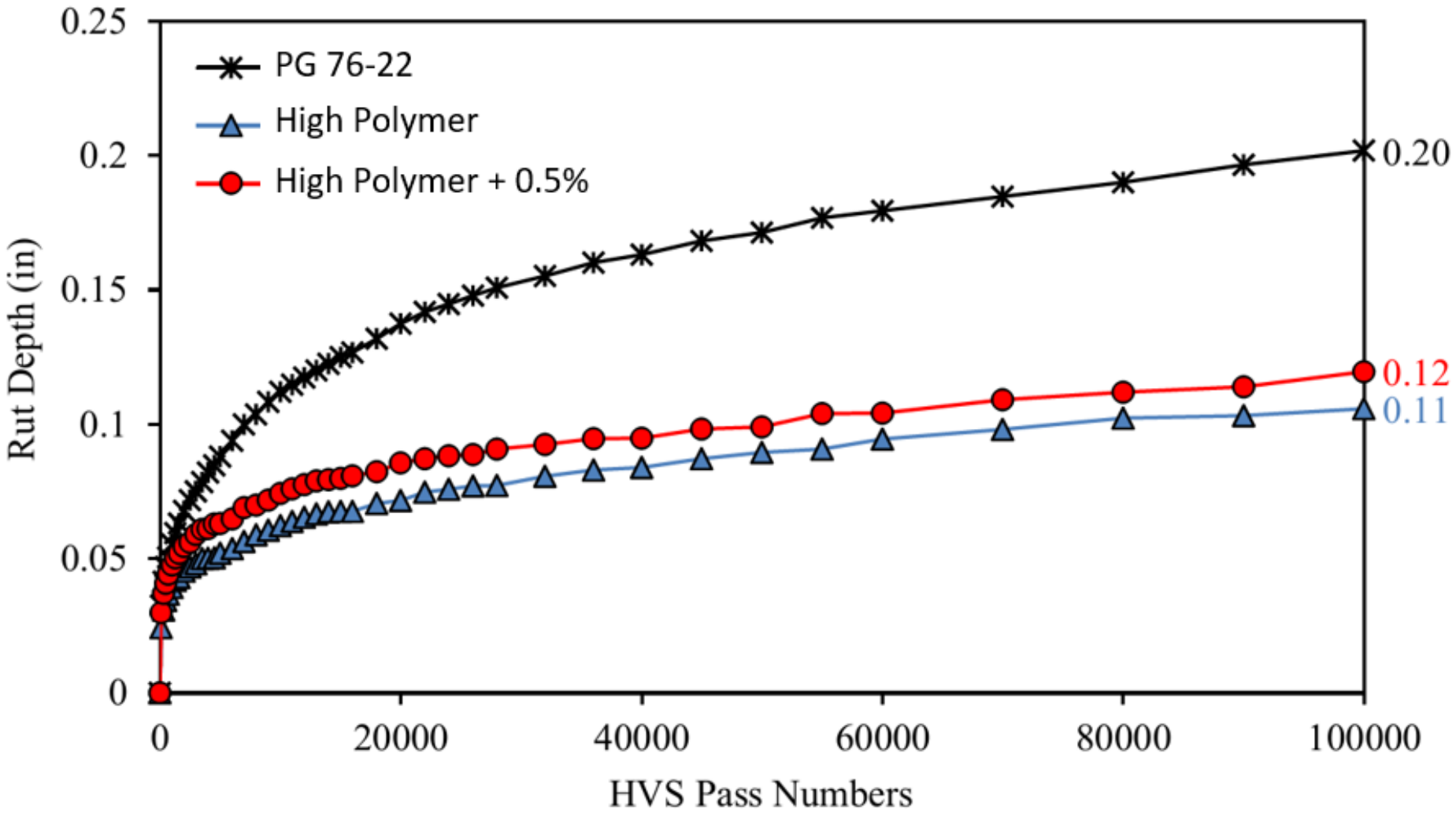
FDOT HiMA Binder Requirements

- SBS or SB polymer only
- No polyphosphoric acid
- No RAP in HP binder mixtures
- More stringent RTFO test residue requirements

Multiple Stress Creep Recovery, $J_{nr,\ 3.2}$ (d, e, f) AASHTO M 332-14	67°C (Modified binders only) 76°C (High Polymer binder only)	"V" = 1.00 kPa^{-1} max Maximum $J_{nr,\ diff}$ = 75% 0.10 kPa^{-1} max
Multiple Stress Creep Recovery, %Recovery (d, e) AASHTO M 332-14	67°C (Modified binders only) 76°C (High Polymer binder only)	$\%R_{3.2} \geq 29.37\ (Jnr,\ 3.2)^{-02633}$ $\%R_{3.2} \geq 90.0$

FDOT HiMA Research (Rutting)

- HiMA (high polymer binder) vs. polymer modified PG 76-22 binder



FDOT HiMA Research (Structural Support)

- Determine the Structural Coefficient for Asphalt Mixes Containing High Polymer Binder
  - Research Organization: University of Nevada Reno
- The objective of this project was to determine the additional structural value of high polymer mixtures compared to asphalt mixtures containing PG 76-22 binder.
- Research showed there is roughly a 20% increase in structural capacity for high polymer binder mixtures.

FDOT HiMA Research (OGFC Durability)

- Evaluation of FC-5 with High Polymer Binder to Reduce Raveling
  - Research Organization: Texas A&M Transportation Institute
- The objective of this research was to determine if the use of high polymer binder in OGFC mixtures (in lieu of PG 76-22 binder) will increase the performance/longevity of OGFC mixtures.
- Research indicated HP binder significantly improved the performance of FDOT's OGFC mixtures and was cost effective.

FDOT HiMA Projects

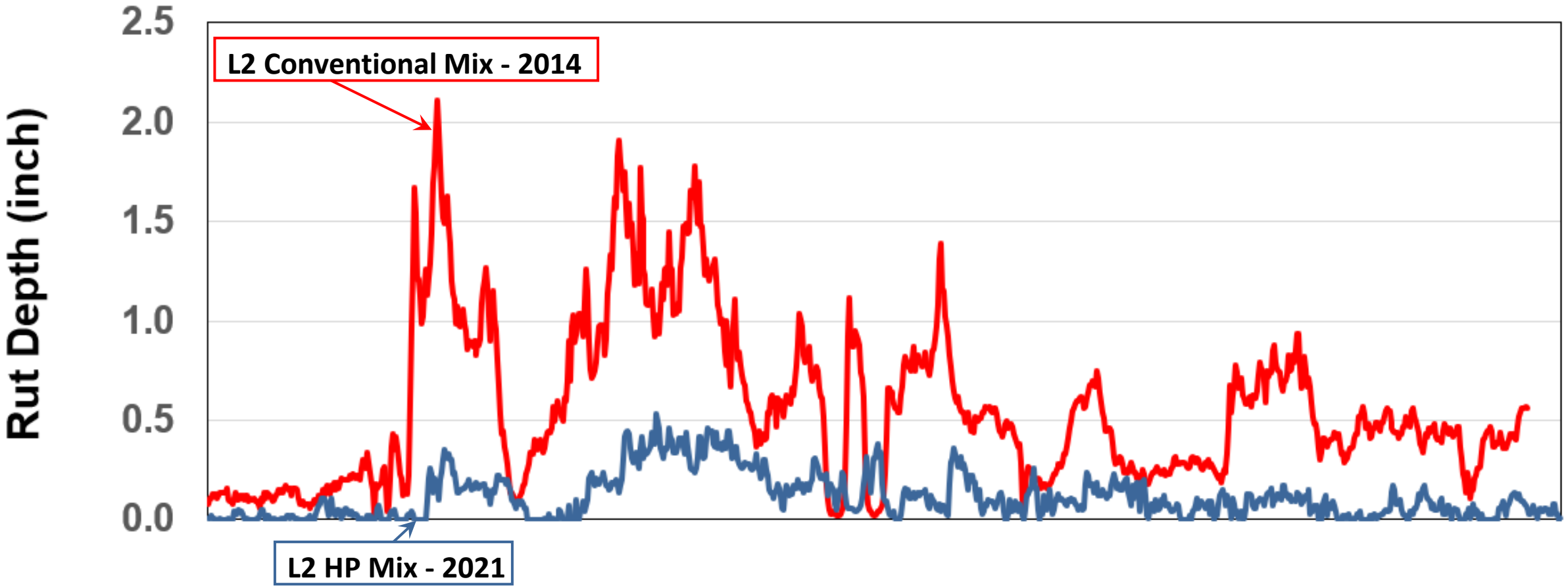
- Placed HiMA mixtures on over 50 projects
- Placed over 600,000 tons of HiMA mix in Florida

Case Study – US 90 in Midway, Florida

Project Information

- US 90 pilot project was paved in August 2015
- Westbound travel lanes at the I-10 interchange
- Between two truck stops
- Rutting up to two inches
- Interim Maintenance project that was programmed to be reconstructed with concrete pavement
- Resurfaced top 2.5” with a single lift of dense graded friction course containing high polymer binder
- Concrete reconstruction cancelled

Project Rutting Data



Lessons Learned

- Supply may be limited
  - Monitor potential projects during design
  - Talk with your HiMA binder suppliers
- HiMA binder is more difficult to produce
  - Good communication needed to assure timely supply
- Expensive
  - Only use it where you need it
- Finite storage period
  - Allowances provided to minimize storage issue
    - Blend down procedure
    - Usage in non-HiMA applications with RAP

Constructability

- Try to avoid hand work areas, but they can be successfully placed with HiMA binder
- Contractors have averaged a bonus on most high polymer projects
- Smoothness data has been good
  - Average IRI for completed projects has ranged from 33 to 47 at acceptance

Further Reading

- FHWA TOPS – “Highly Modified Asphalt – Florida Department of Transportation Case Study 2-pg Report”
- FHWA TOPS – “Stone Matrix Asphalt – Georgia Department of Transportation Case Study 2-pg Report”

- Read more about TOPs at: https://www.fhwa.dot.gov/pavement/tops/

Stone Matrix Asphalt (SMA)
Highly Modified Asphalt (HiMA)

Q & A

Please Register for Upcoming Webinars

- Webinar 1: HPTO/CAM
- Webinar 2: Concrete Overlays
- Webinar 3: SMA/HiMA
- **Webinar 4: Concrete over Concrete Unbonded (COC-U)**
- **Webinar 5: UTBWC/OGFC**
- **Webinar 6: Concrete over Asphalt Unbonded (COA-U)**
- **Webinar 7: ARGG/EFO**
- **Webinar 8: Concrete over Asphalt Bonded (COA-B)**

Find out more at:

https://www.fhwa.dot.gov/pavement/tops/

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