Benefits of High Polymer in Asphalt Paving

63rd Annual PAPA Conference
Hershey, PA
January 18, 2023

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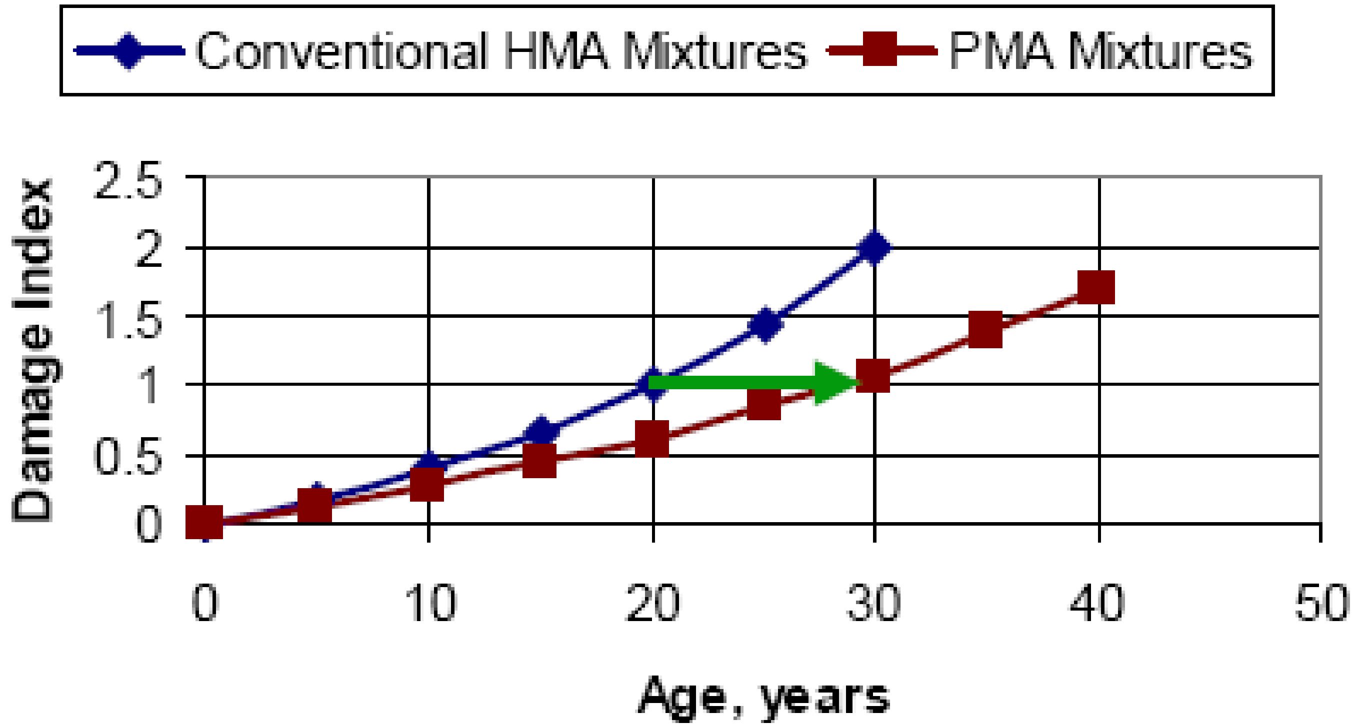
Polymer Modification

- Polymers have been added to asphalt binders worldwide since the 1970s
- It has been well documented that the addition of polymer substantially improves the performance and increases the life of asphalt pavements

Asphalt Institute Polymer Modified Asphalt (PMA) Performance Study

- Titled “PMA for Enhancing HMA Performance”
- Studied data from hundreds of Long Term Pavement Performance (LTPP) sections across the United States
- Main objective:
  - Quantify the effect of using PMA as compared to conventional mixtures in terms of increasing pavement life and reducing the occurrence of surface distress.

Expected Service Life Increase for a 20-year Design*



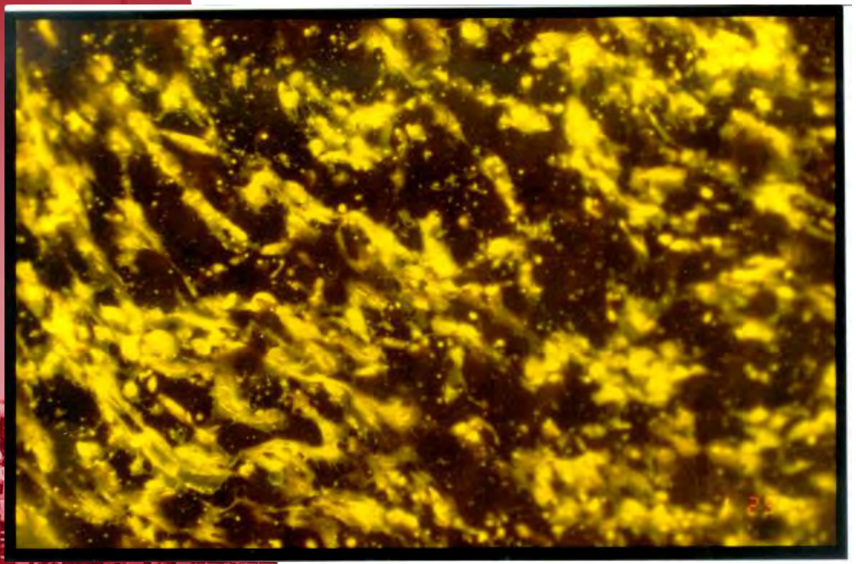
*Harold von Quintus, “Polymer-Modified Asphalts- Enhancing HMA Performance,” AMAP Annual Meeting, February 10, 2004

Polymer Modification

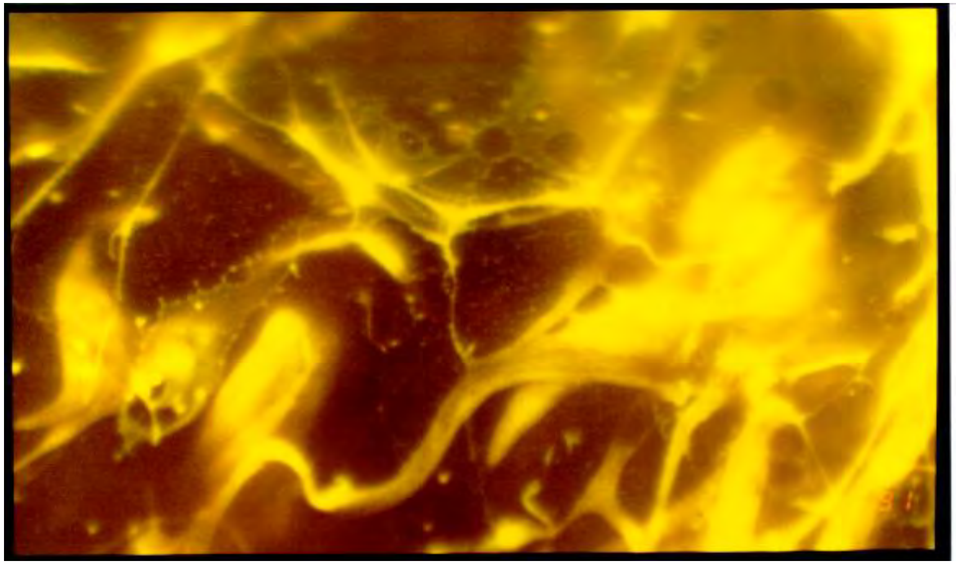
- Polymers are chosen based on adding beneficial properties to the asphalt
  - Increase resistance to rutting at high temperatures
  - Improve resistance to cracking at intermediate and low temperatures
  - Retain workability
- Polymers are chosen based on their ability to build a network within the asphalt
  - Stability – won't separate in storage
- Predominate polymer used today that meets these requirements is Styrene-Butadiene- Styrene (SBS)

Polymer Modification

Monitoring the Curing Process with an Ultraviolet Microscope



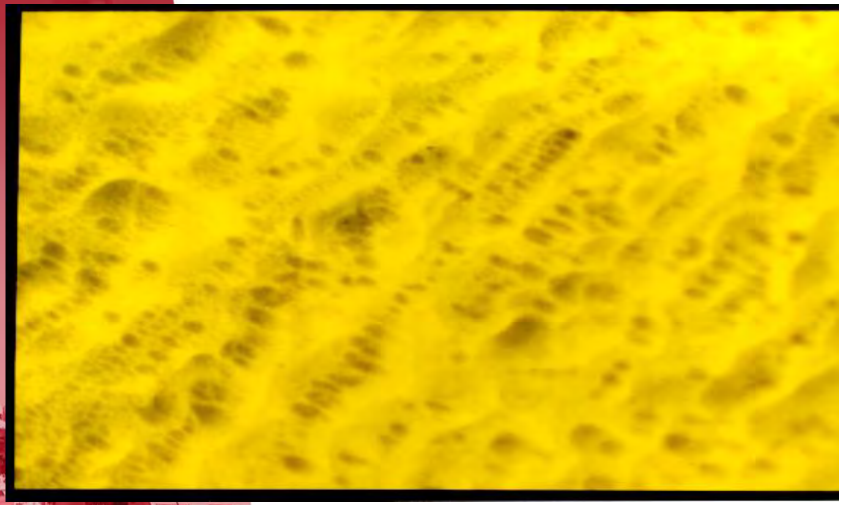
Initial Stage – High Shear Milling



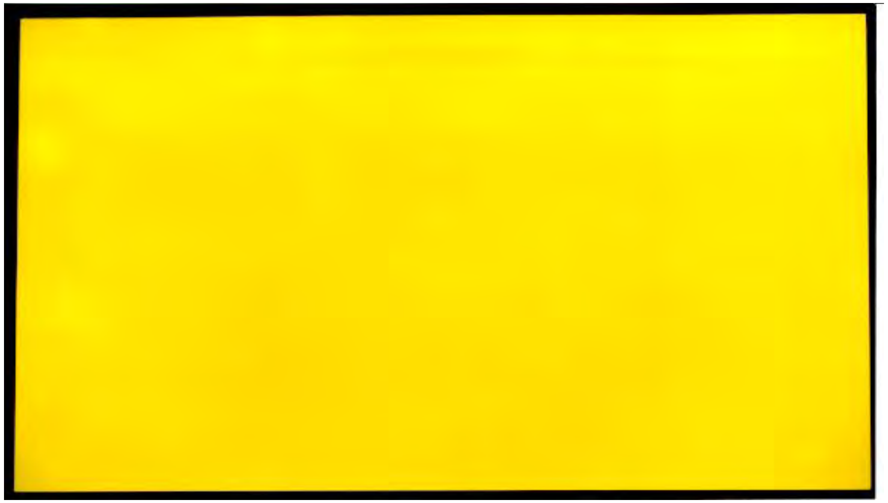
Final Stage – High Shear Milling

Polymer Modification

Monitoring the Curing Process with an Ultraviolet Microscope



Intermediate Stage – Cross-Linking



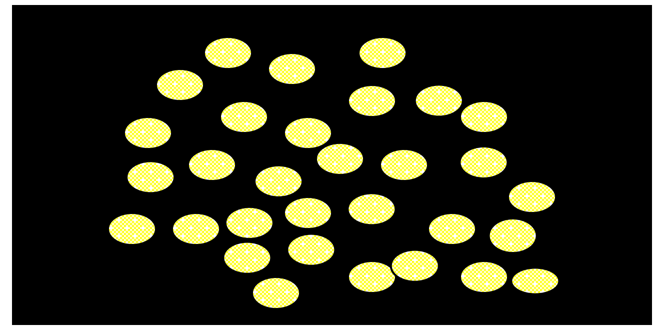
Fully Cured PMA

Polymer Modification

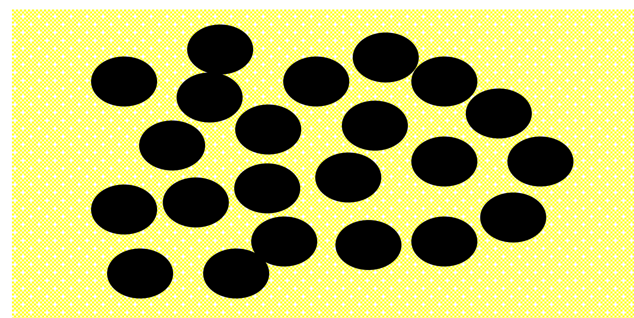
- Typical polymer modified asphalts contain 3-4% polymer (e.g. PG 64E-22)
- **Hi**ghly **M**odified **A**sphalt (HiMA) typically contains 7.5% polymer
- Adding 7.5% polymer improves performance more than expected by just increasing polymer percentage
- HiMA is typically designated as a PG 76E-28.
- HiMA True Grade is approximately PG 90-32

Morphology of Polymer Modified Asphalt Binders

Polymer exists as a separate phase dispersed in the asphalt phase. (~1-5 wt.% polymer) This is the most commonly observed system.



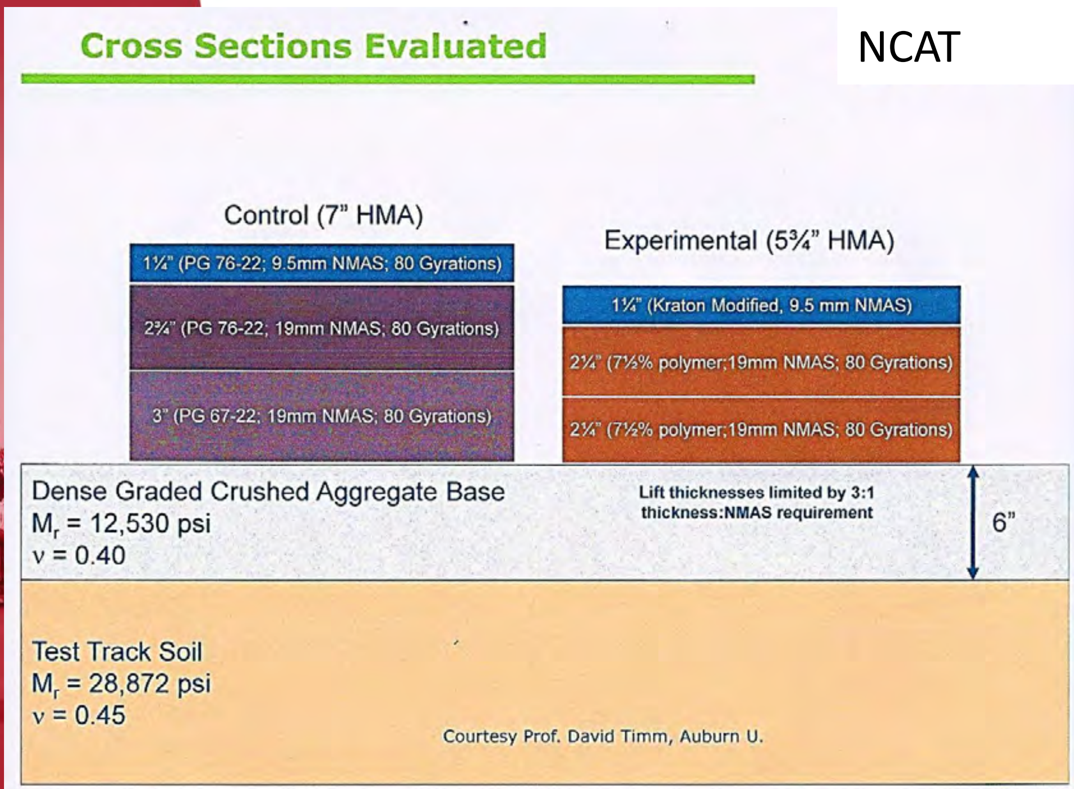
At higher polymer content (>7w%) the phases invert with asphalt phase domains dispersed in the continuous polymer phase.



Storage of Polymer Modified Asphalt Binders

- Standard **P**olymer **M**odified **A**sphalt (PMA) ends the curing process (i.e., building a polymer network in the asphalt phase), usually before it leaves the terminal.
- Storage time for a standard PMA (e.g., PG 64E-22), is typically months
- Because the phases are reversed, HiMA continues the curing process indefinitely. As the polymer network grows, the viscosity increases.
- This reduces storage time for HiMA to weeks, rather than months

NCAT Test Track HiMA Section



NCAT

- July 2009 - NCAT Test Track Section N7 placed using HiMA
  - No problems with production and placement
  - Mix behaved like conventional PG 76-22

NCAT Test Track HiMA Section

- 10 million ESALs applied by September 2011
- HiMA section performed better than or equal to control section despite 1.25” thinner
  - HiMA section had 50% of rutting in control section
  - No cracking in HiMA or control section
    - Measured strain and laboratory testing indicate HiMA has 64 times the fatigue life of the control section

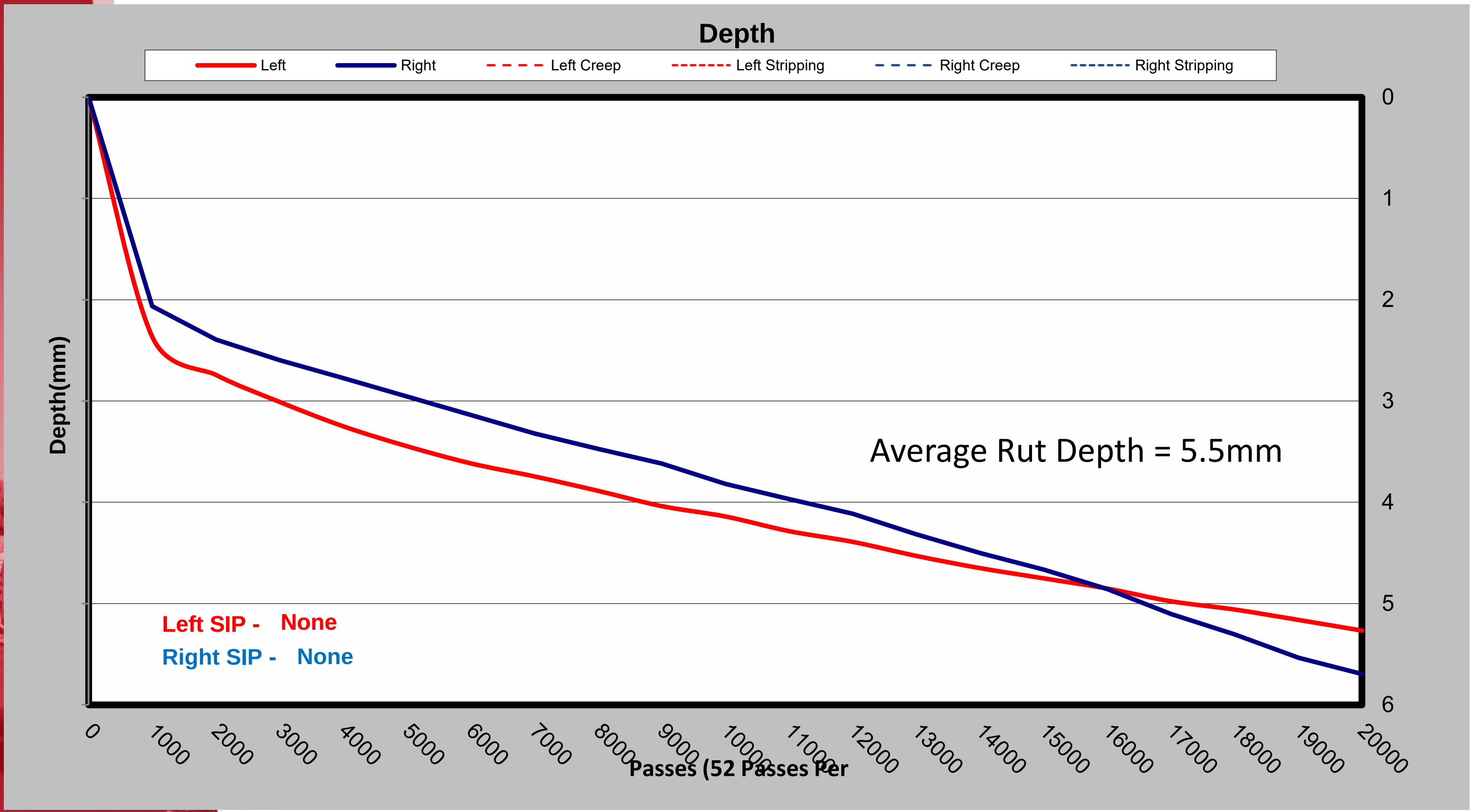
HiMA Applications

- HiMA can been used in multiple mix types
  - Dense graded
  - SMA
  - OGFC
- PennDOT has used HiMA in two projects to date
- PennDOT is renaming HiMA as **H**ighly **P**olymerized **A**sphalt **B**inder (HPAB)

PennDOT HiMA Projects

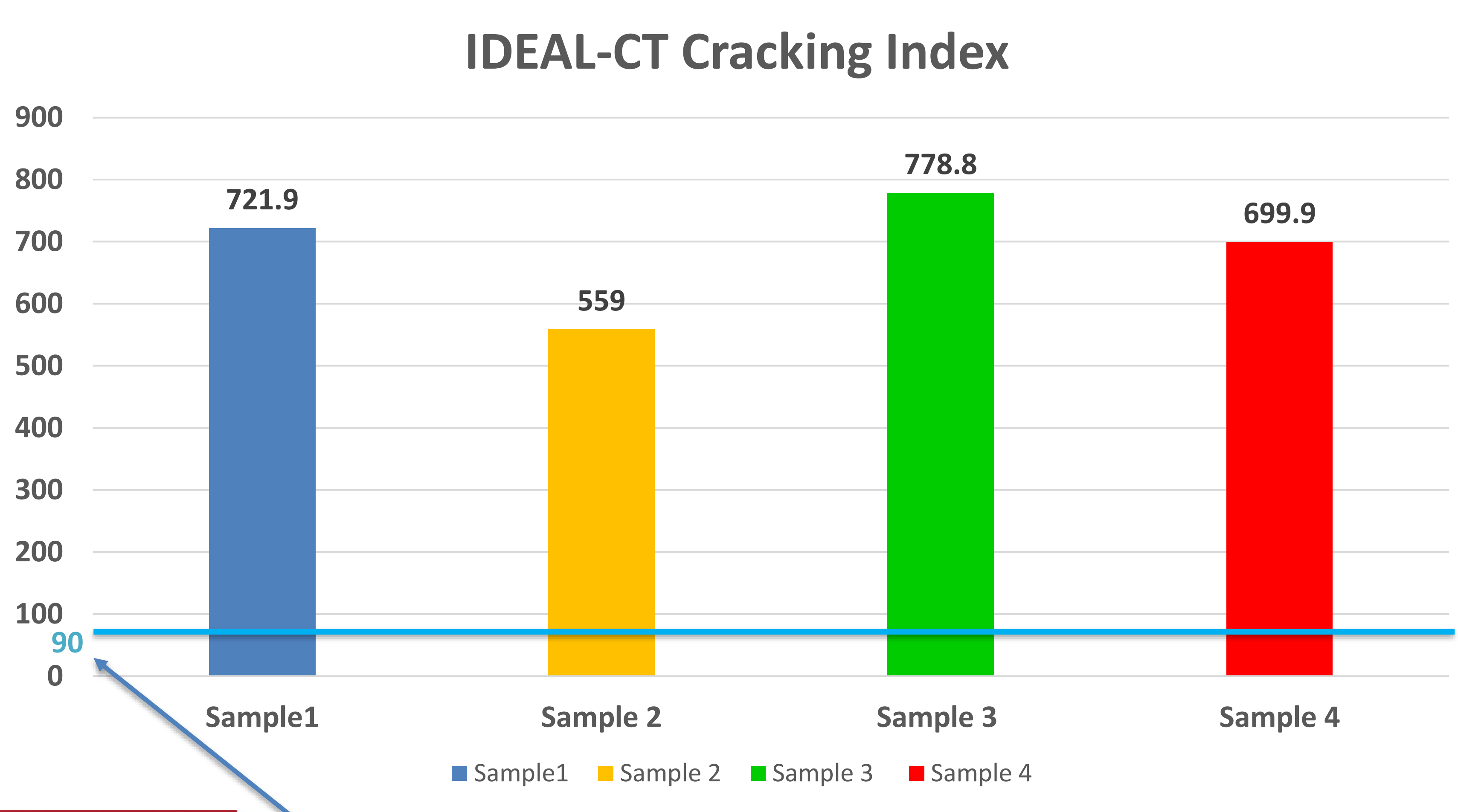
- Lindy Paving, SR 79 SB
- 9.5mm SMA mix

Hamburg Wheel Tracking Test



PennDOT Requirement Maximum Rut Depth = 10 mm

IDEAL-CT Cracking Index



PennDOT Requirement Minimum Cracking Index = 90

Average IDEAL-CT Cracking Index = 689.9

Lindy Paving SR 79 SMA w/ HiMA

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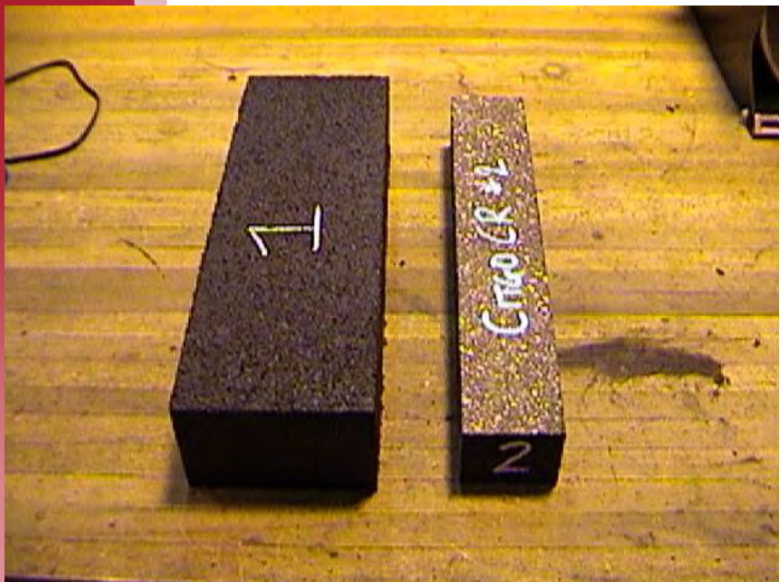
PennDOT HiMA Projects

- Glasgow Inc, I-95
- 9.5mm **B**ridge **D**eck **W**aterproof **S**urface **C**ourse (BDWSC) mix with HiMA binder

BDWSC Mix Specification

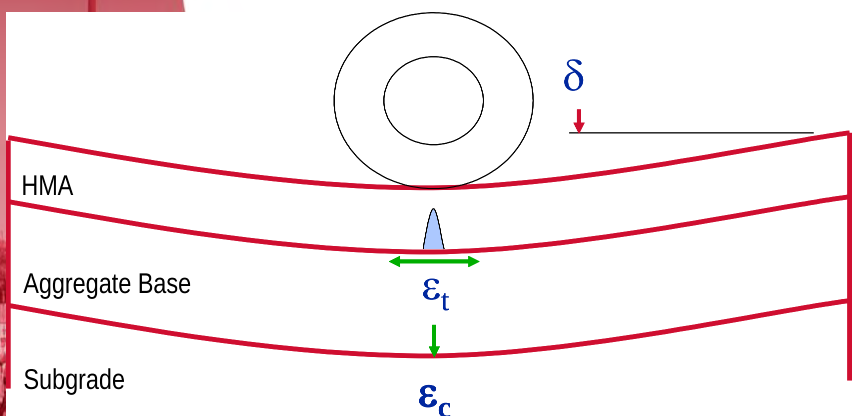
- NJDOT and Rutgers University developed a Bridge Deck Waterproof Surface Course (BDWSC) which utilizes HiMA
- 9.5mm mix designed at 1.5% air voids to provide impermeable mix
- Must have a stringent mix rut test requirement
- APA Rut Depth < 3 mm
- Glasgow BDWSC mix had APA Rut depth average = 1.75 mm

BDWSC Fatigue Test



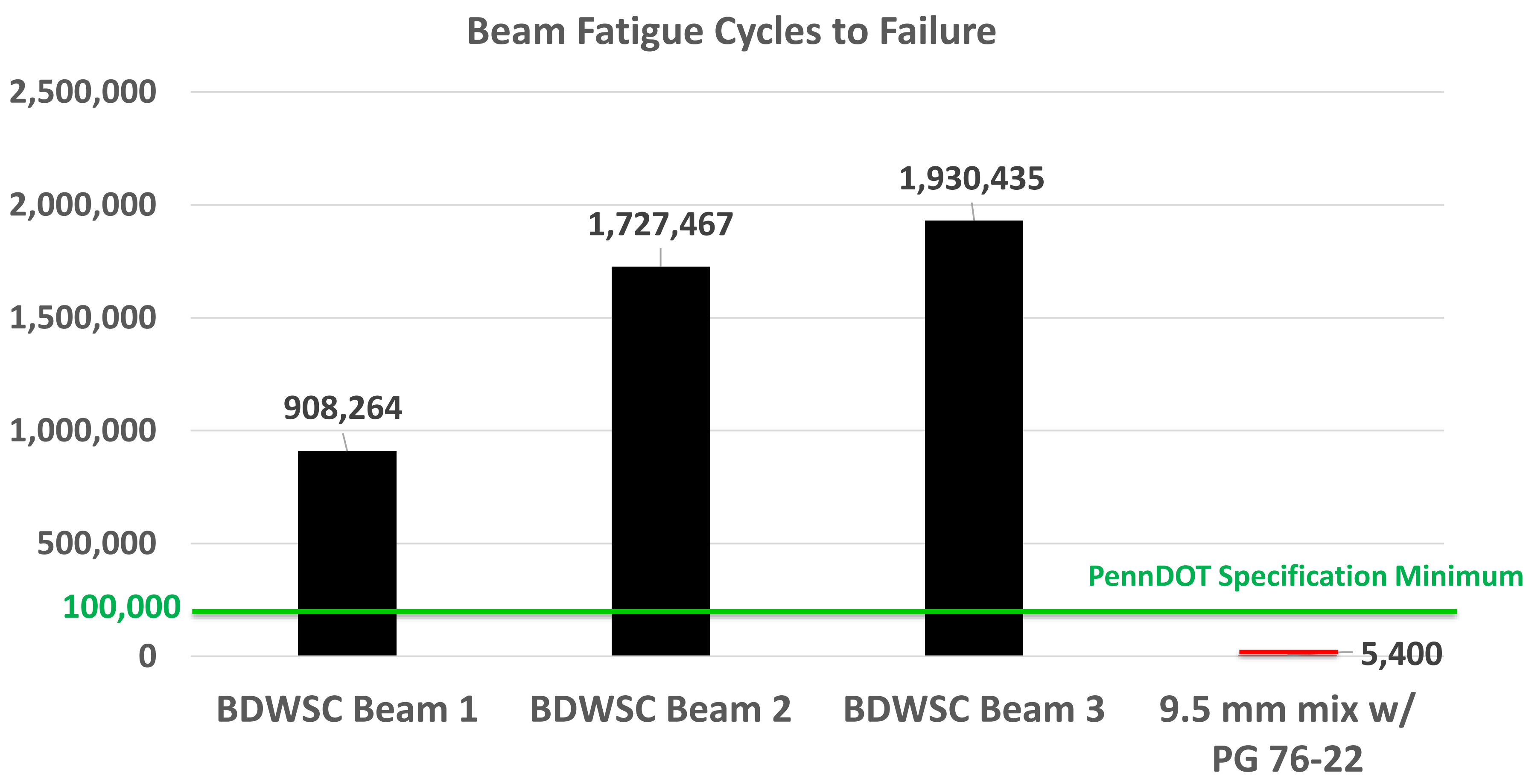
- Bridge decks have much greater vertical movement than highways
- Must have a stringent fatigue cracking specification
- Flexural Beam Fatigue Device, AASHTO T-321
  - Tests mix's ability to withstand repeated bending which causes fatigue failure
  - Data = number of loading cycles to failure (loss of stiffness)

BDWSC Fatigue Test



- Beam Fatigue Test typically run at 900 μ-strain and 10 Hz (high deflection, slow moving vehicle)
- Typical strain levels in asphalt pavements < 200 μ-strain
- For additional vertical movement in bridge decks, test for BDWSC is run at 1500 μ-strain
- NJDOT & PennDOT require > 100,000 cycles to failure

Glasgow, Inc Beam Fatigue Results



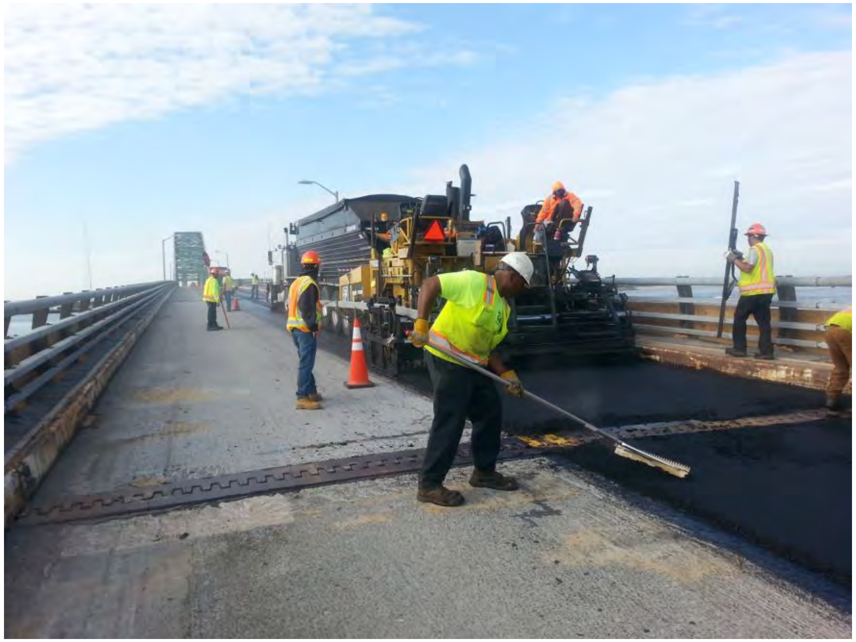
Average Beam Fatigue Value = 1,522,055 cycles

Glasgow, Inc I-95 BDWSC Mix

Glasgow, Inc I-95 BDWSC Mix

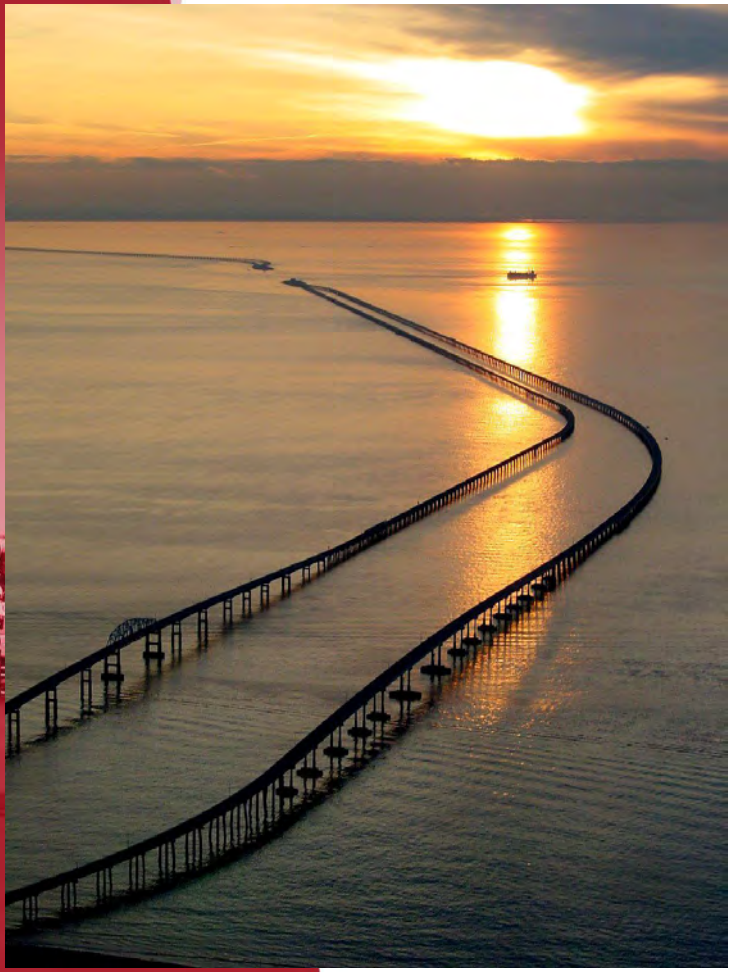
BDWSC Projects

NJ Route 87 Absecon Inlet Bridge



NYS DOT Robert Moses Causeway

Chesapeake Bay Bridge Tunnel



- PAPA member Allan Myers recently repaved the 18 mile long Chesapeake Bay Bridge Tunnel with BDWSC mix and HiMA asphalt binder

BDWSC Projects – George Washington Bridge (GWB)

- GWB presents extreme challenge to asphalt mix
- Orthotropic steel deck – substantial vertical movement
- Most heavily trafficked bridge in the world – 108 million vehicles per year
- BDWSC mix performing well after ten years

HiMA Binder in HPTO Mix on 1st Avenue in NYC (2013)

- 1st Avenue from 72nd Street to 125th Street in Manhattan was a 29 year old 18" thick PCC pavement
- Cost of total replacement far beyond NYC DOT budget
- NYC DOT contacted Associated Asphalt and asked for suggestions
- Proposed putting Highly Modified Asphalt (HiMA) binder into High Performance Thin Overlay Mix (HPTO)

1st Avenue in NYC - 2013

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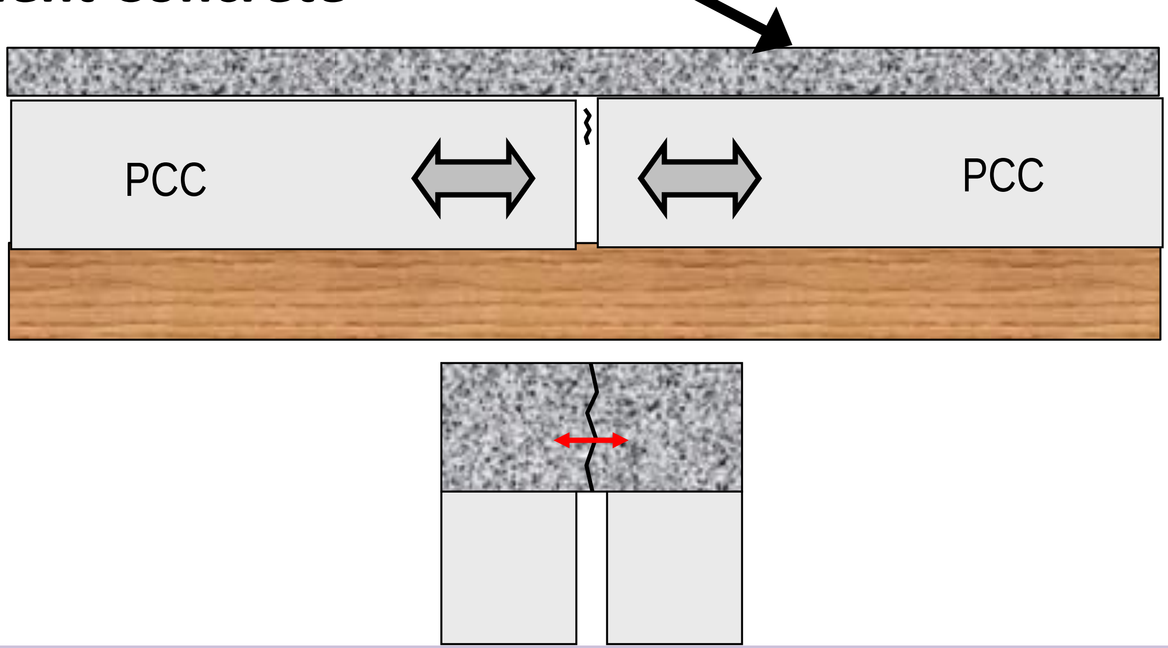
Texas Overlay Tester

Asphalt Mix Overlaid on Portland Cement Concrete



Horizontal Tensile Stress due to Expansion/Contraction of PCC from Temperature

Horizontal Stress/Strain is modeled using Texas Overlay Tester

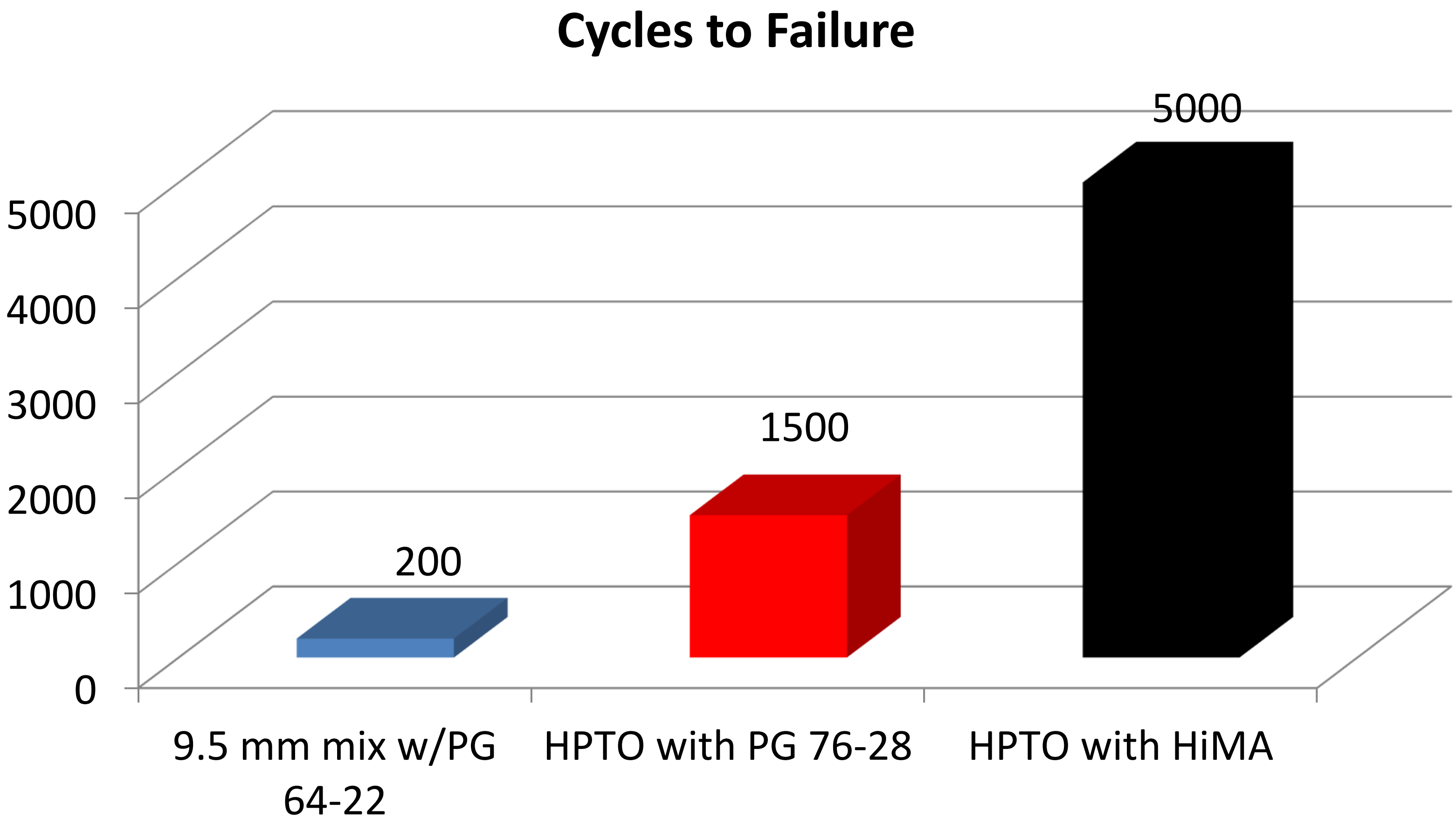
Texas Overlay Tester

Movable plate

Fixed plate

Saw cut gyratory specimen and glue onto both plates

Texas Overlay Tester Results



1st Avenue in NYC - 2013

- Rehabilitation Design
  - Micro-mill existing PCC pavement
  - Patch areas as required with asphalt mix
  - Crack seal as required
  - Place PG 76-22 tack coat and Mirafi PGMG4 fabric
  - Overlay with 1 ½” HPTO mix with HiMA asphalt binder
    - Added Evotherm warm mix additive to lower mix temperatures and improve workability
    - Produced mix at 300°F
- Project completed by September 2013

1st Avenue – New York City 2013
Micro-mill Existing Pavement

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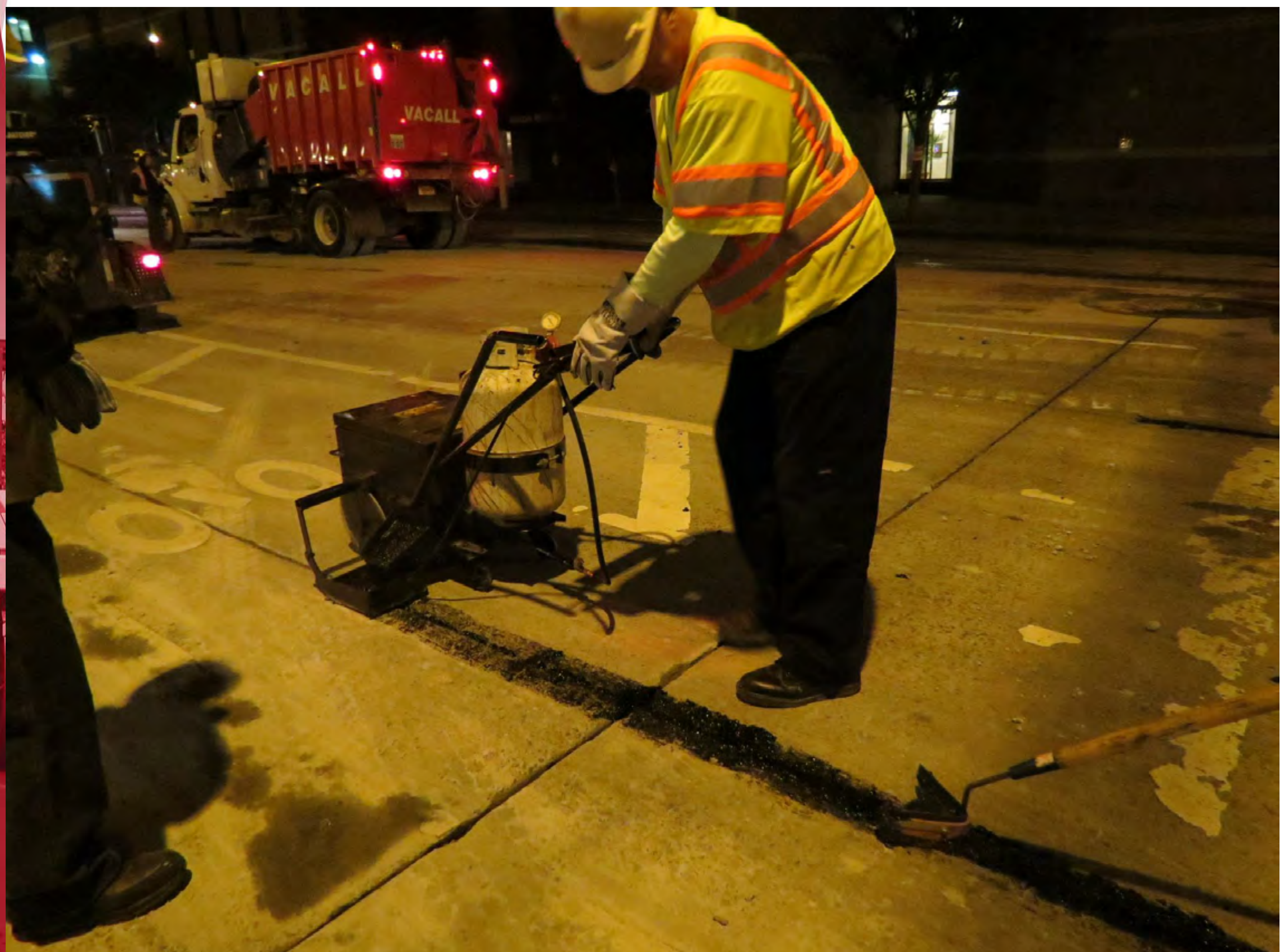
Micro-mill Existing Pavement

1st Avenue – New York City 2013
Crack Seal and Patch Existing Pavement



1st Avenue – New York City 2013
Crack Seal and Patch Existing Pavement

1st Avenue – New York City 2013 Apply PG 76-22 Tack Coat and Paving Fabric

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1st Avenue – New York City 2013
Pave with 1.5” HPTO Mix

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1st Avenue – New York City 2013 Finished HPTO Pavement

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1st Avenue – New York City 2013 Finished HPTO Pavement

1st Avenue Finished HPTO Pavement – September 2013

NYC DOT Press Release

NYC DOT Commissioner Sadik-Khan Announces Innovative Resurfacing of 53-block Stretch of First Avenue, the Latest in $6 Billion of State of Good Repair Projects in Just Six Years

New York City Department of Transportation (DOT) Commissioner Janette Sadik-Khan today announced the completion of a $7 million project to resurface First Avenue from 72nd to 125th streets using an innovative, thin-asphalt overlay atop the notoriously uneven concrete road at a fraction of the cost of a complete rebuilding.

"The high-tech asphalt overlay resurfacing of First Avenue will bring relief to residents and businesses who suffered 24/7 from the earth shattering pounding of vehicles barreling up First Avenue on what was previously a concrete roadway," said Council Member Jessica Lappin.

HPTO Pavement
1st Avenue – August 2018

HPTO Pavement
1st Avenue – August 2018

HPTO Pavement
1st Avenue – August 2018

HPTO Pavement
1st Avenue – October 2022

HPTO Pavement

1st Avenue – October 2022

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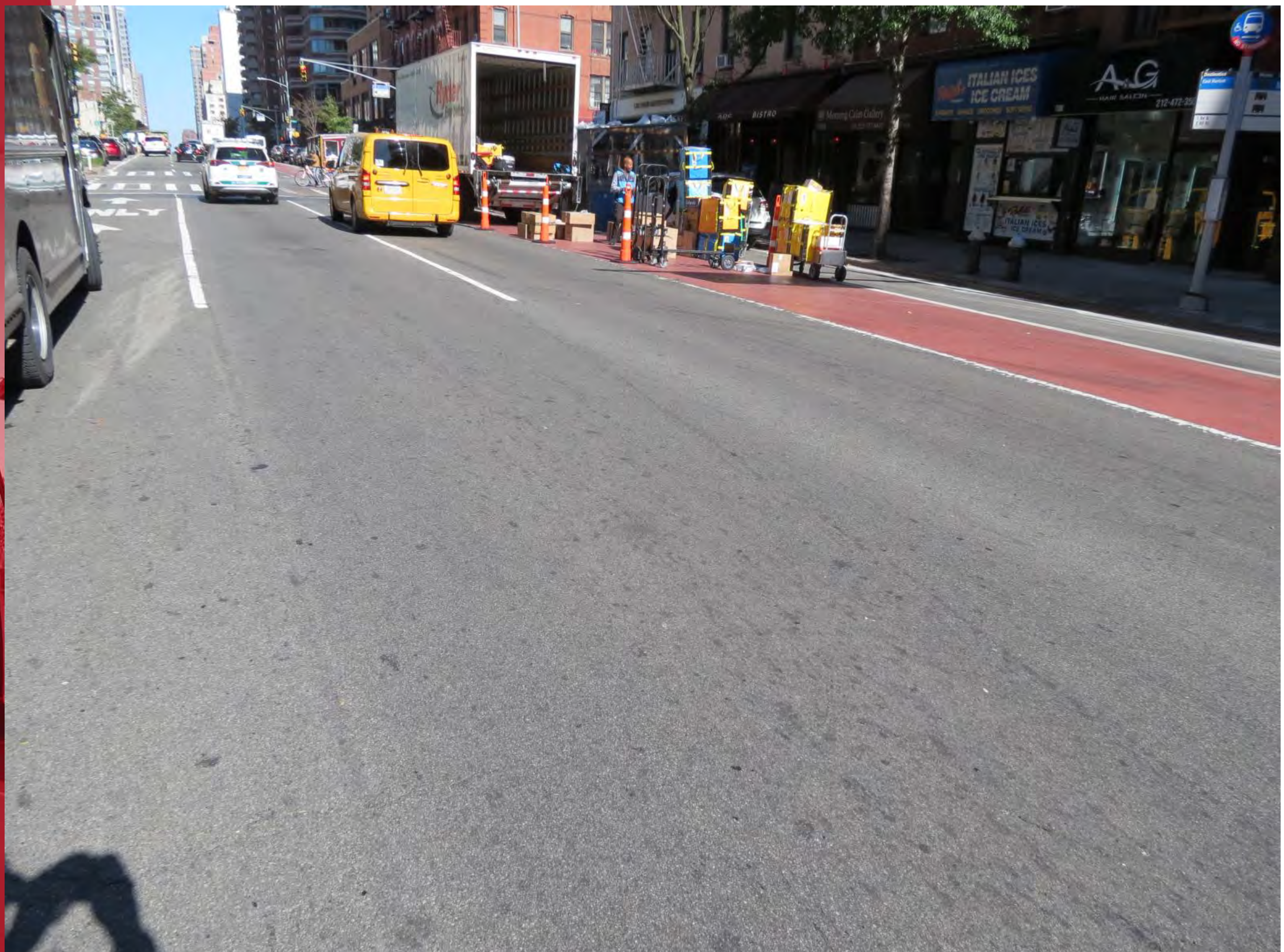
HPTO Pavement
1st Avenue – October 2022



HPTO Pavement
1st Avenue – October 2022

1st Avenue in NYC - Summary

- NYC DOT stated they would be satisfied if the pavement on 1st Avenue lasted five years
- After nine years, including two polar vortex winters, it is still in very good condition
- The combination of HPTO mix and HiMA binder provided a solution to urban pavement problems

HiMA Summary

- HiMA substantially increases resistance to rutting and cracking in asphalt pavements
- Used properly, it can significantly increase the life of asphalt pavements
- It places another tool in the pavement designer’s toolbox

Questions?

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