The Development and Use of High Performance Thin Overlay Systems

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Ronald Corun
Manager - Asphalt Technical Services
NuStar Asphalt Refining LLC

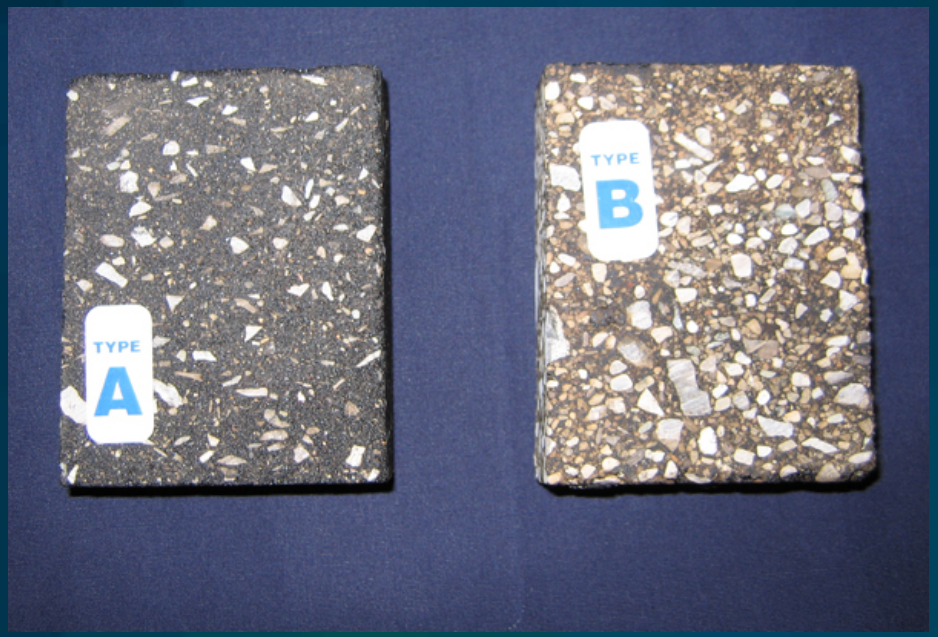
HMA Thin Surface Mixes

- **Not New – in use since the early 1900's**
- **Originally all fine aggregate – plus AC**
  - **Could work well in low stress application**
  - **But tended to rut and crack under higher traffic /stress**

HMA Thin Surface Mixes

- **City of Rockville, Maryland – 1960's**
  - **Fine graded Marshall mix with AC-10**
  - **Named it Smoothseal**

HMA Thin Surface Mixes



- **Ohio DOT**
  - **Borrowed Rockville idea and product name**
  - **First use in 1960's**
  - **Added polymers in 1990's**
  - **Type A – 5/8" thick**
    - **Sand mix with 8.5% AC**
  - **Type B – ¾" thick**
    - **4.75 mm mix with 6.4% AC**

HMA Thin Surface Mixes

- **Ohio DOT**
  - **Oldest Smoothseal pavement has lasted 28 years**
  - **Average life of Smoothseal overlay**
    - **Over Asphalt – 16 years**
    - **Composite pavement – 7-11 years (depending on traffic)**

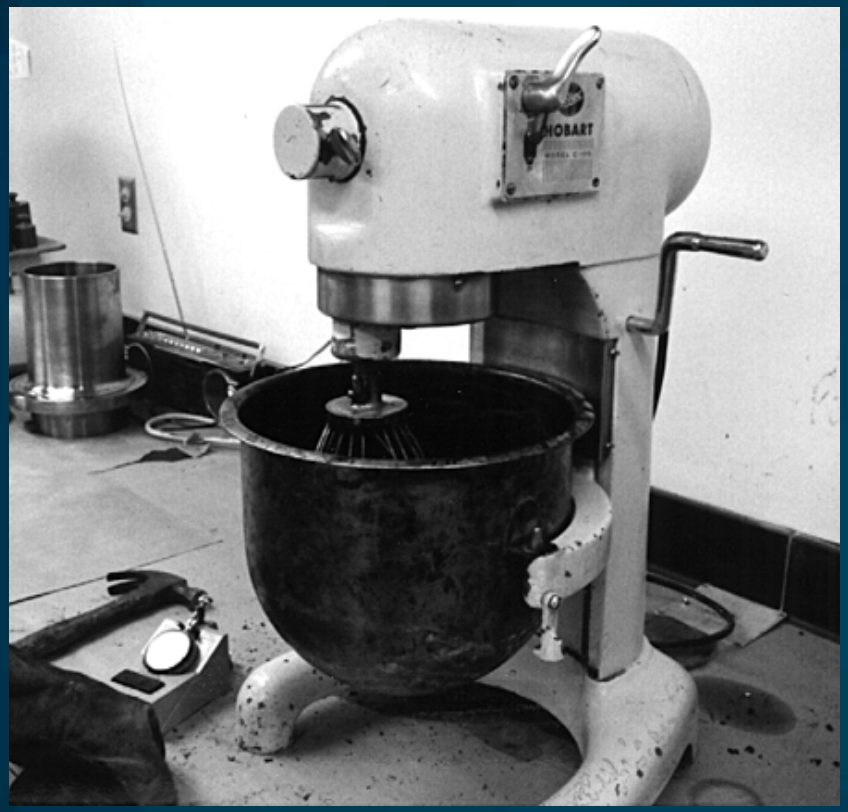
HMA Thin Surface Mixes

- **Superpave research successful in reducing rutting on major highways – typically coarser and drier mixes**
- **Superpave mixes perhaps not suited for low volume secondary and subdivision roads – including 4.75 mm mix**
  - **Harder to place – handwork issues**
  - **Harder to compact**
  - **Shorter life span**
    - **Durability**
    - **Fatigue life**

HMA Thin Surface Mixes

- **SP 4.75 mm mix**
- **Re-designed mix to produce High Performance Thin Overlay**
- **HPTO – designed to overcome problems with older Thin Surface Mixes**

HPTO Design



- **Requirements**
  - **Improve Durability**
    - **Higher AC/ film thickness mix (VMA)**
    - **Dense / non-segregating mix (in-place density)**
  - **Rut & Crack Resistant**
    - **PMA Binder**
    - **High quality aggregates**
    - **Mix performance test**

HPTO – Developed to meet Two Applications

Local & Secondary Roads

- **Suburban development**
  - **Higher traffic and stress on pavement**
  - **Intolerance of traffic interruption (get-in & get-out and don't come back)**
  - **Usual maintenance treatments no longer acceptable**

Primary & Interstate Hwy

- **Budget shortfalls require delays in some normal rehabilitations**
- **Need to provide a "maintenance" application until next major rehab**
- **HPTO can provide a solution**

HPTO Applications

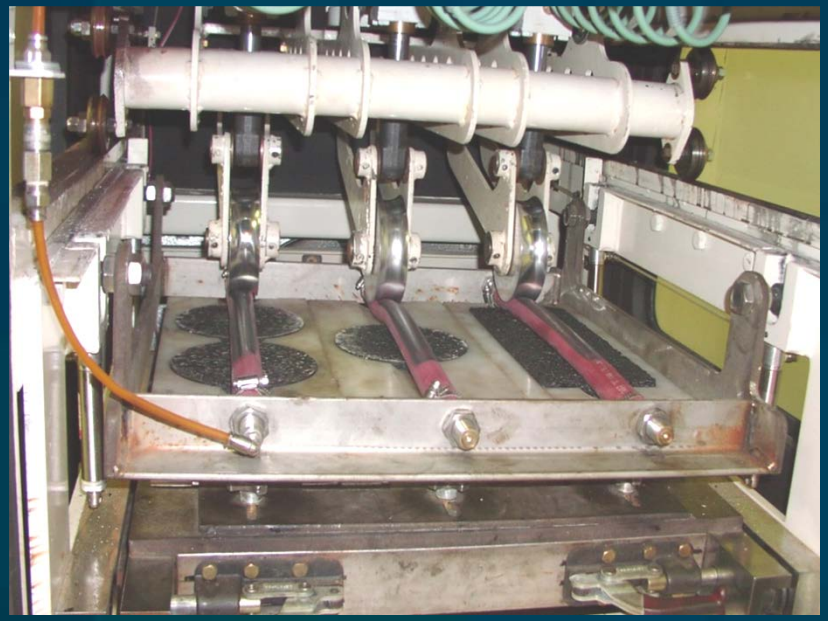
Local Use

DOT Use

Development of the HPTO System

- **Research Objectives**
  - **Longer life material**
    - **Adhesion to underlying pavement**
    - **Rutting**
    - **Fatigue cracking**
    - **Durability**
  - **Use local aggregates**
  - **Friendly to local contractors**
  - **Good Constructability**
  - **Cost effective product**
    - **Can be placed ¾” – 1 ¼” thick**
    - **Little milling required**

Development of the HPTO System

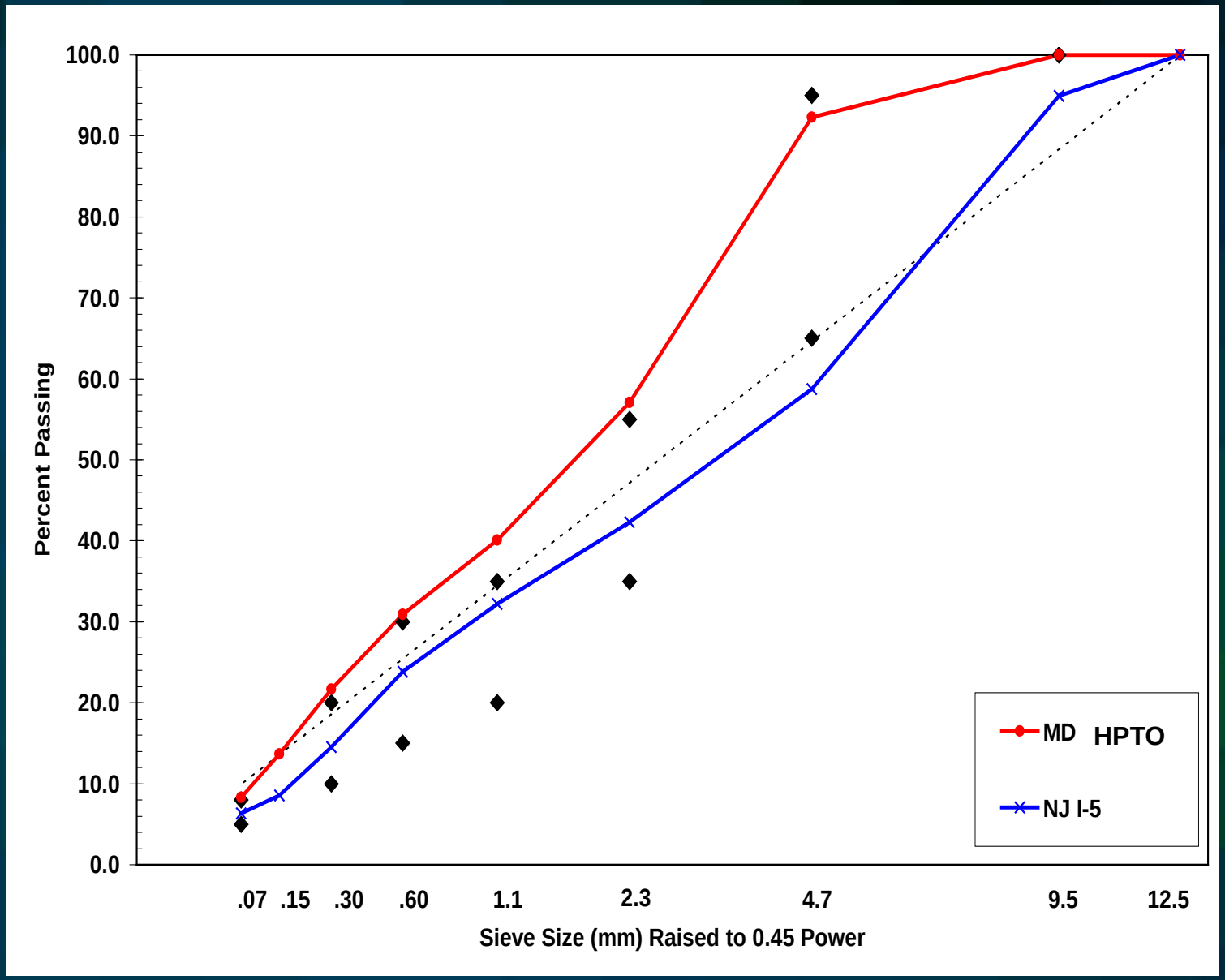


- **Achieving Research Objectives**
  - **Rutting Performance**
    - **Quality aggregates**
    - **Good aggregate gradation**
    - **Specially Engineered Polymer-Modified Asphalt (PMA)**
    - **Mix performance test (APA, Hamburg, AMPT)**

Development of the HPTO System

- **Achieving Research Objectives**
  - **Fatigue cracking**
    - **Increased asphalt content**
      - **Slightly gap-graded mix**
      - **Mix design at 3% air void target (SGC = 50 gyrations)**
      - **Minimum 7% asphalt content**
    - **Specifically designed to increase fatigue life**
      - **Thicker asphalt film coatings – min. VMA = 18%**
      - **Greater resistance to aging**

HPTO & 9.5 mm Mix Gradation Plot



Development of the HPTO System

- **Achieving Research Objectives**
  - **Balanced Performance**
    - **NCAT test track**
    - **Higher binder content possible with no rutting when PMA used**
    - **National study - PMA**
      - **National study – increased pavement life of 5-7 years**
      - **Significant fatigue life improvement**

Initial Installation of the HPTO for Local Roads

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Main entrance road**
  - **20 year old existing HMA pavement**
  - **Approximately 5 loaded tanker trucks per day**
  - **Substantial fatigue cracking**
  - **Rutting not an issue**
  - **Minimal pavement deflection under loads**

Initial Installation of the HPTO System

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Full depth HMA patching section in one lane**
  - **Compare performance**

Initial Installation of the HPTO

- **Construction objectives**
  - **Adhesion to underlying pavement**
    - **Require clean and dry pavement**
    - **Use PG 64-22 as tack coat material**
    - **Require complete and even coverage**

Initial Installation of the HPTO System

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Constructability**
    - **Specification density achieved easily**
      - **7% AC content and 3% design air voids makes compaction easier**

Initial Installation of the HPTO System

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Constructability**
    - **Required laydown temperature is only 300° - 310°F**

Initial Installation of the HPTO System

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Constructability**
    - **Handwork not a problem**

Initial Installation of the HPTO System

- **NuStar Asphalt Refinery in Paulsboro, NJ**
  - **Constructability**
    - **Transverse and longitudinal joints are excellent**
    - **Project appearance is very good**

Paulsboro HPTO – Pavement Evaluation

- **Evaluation each year**
  - **Rut & crack survey**
  - **Pavement coring**

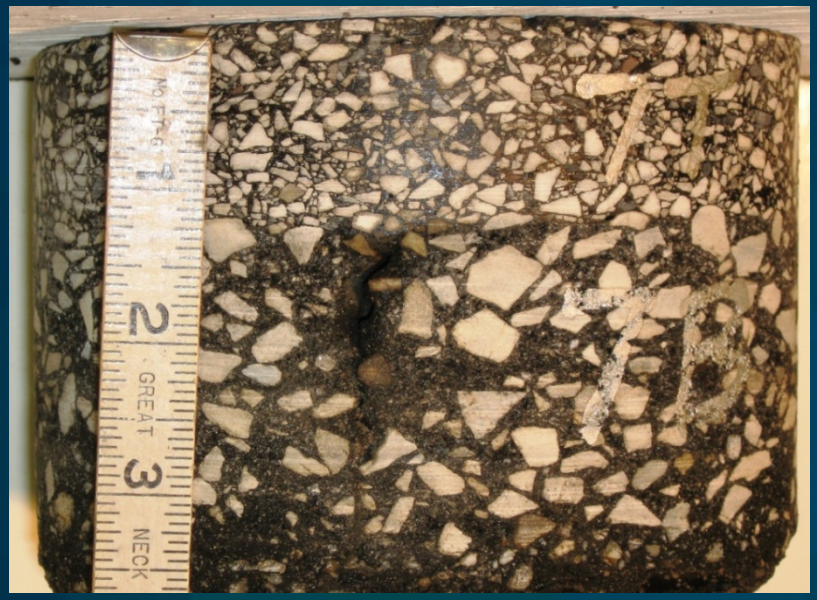
Paulsboro HPTO – 3 years old

Original

After 3 years

Paulsboro HPTO – after 3 years

Paulsboro HPTO - Cores



Harford County HPTO Project

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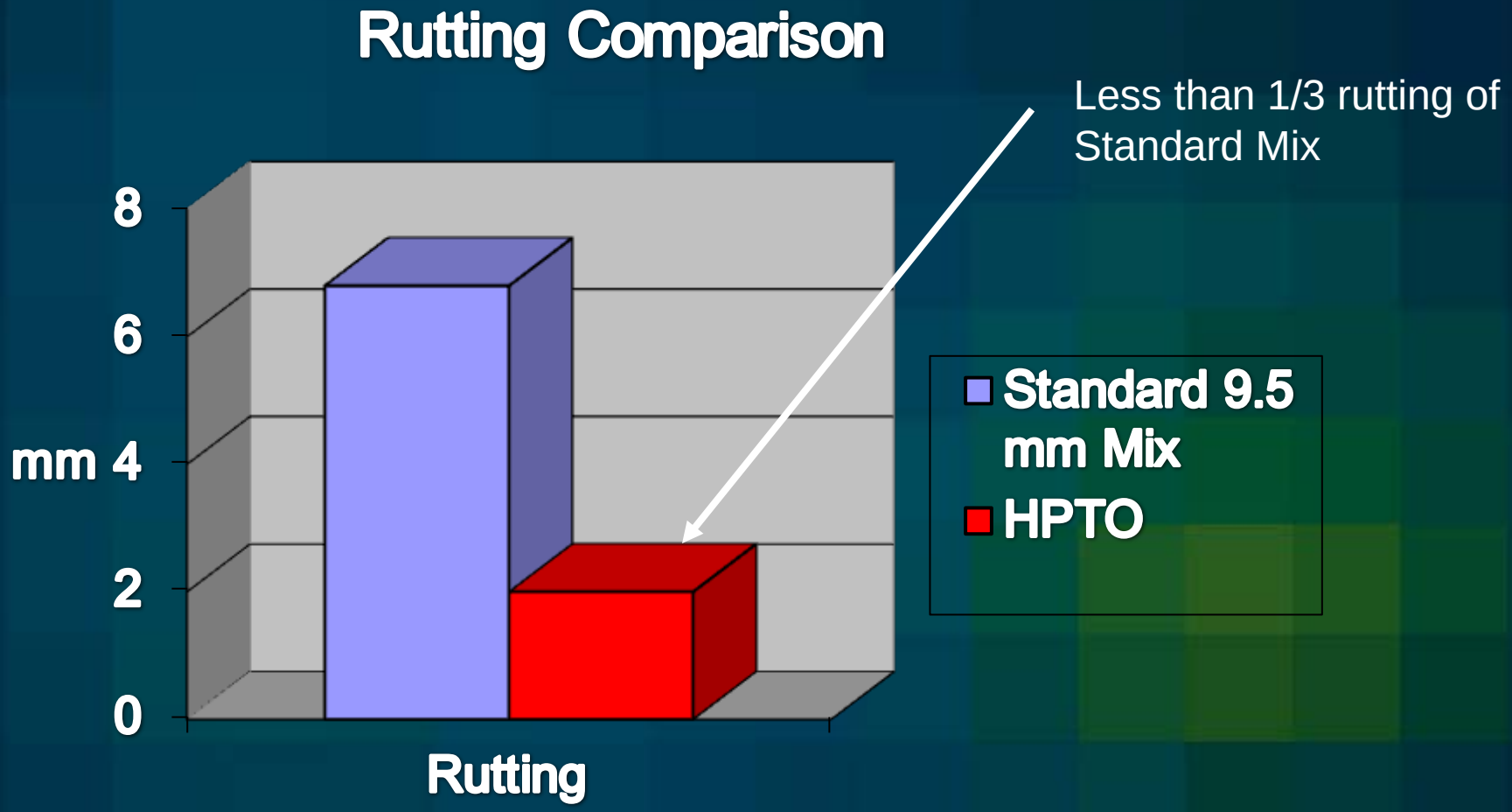
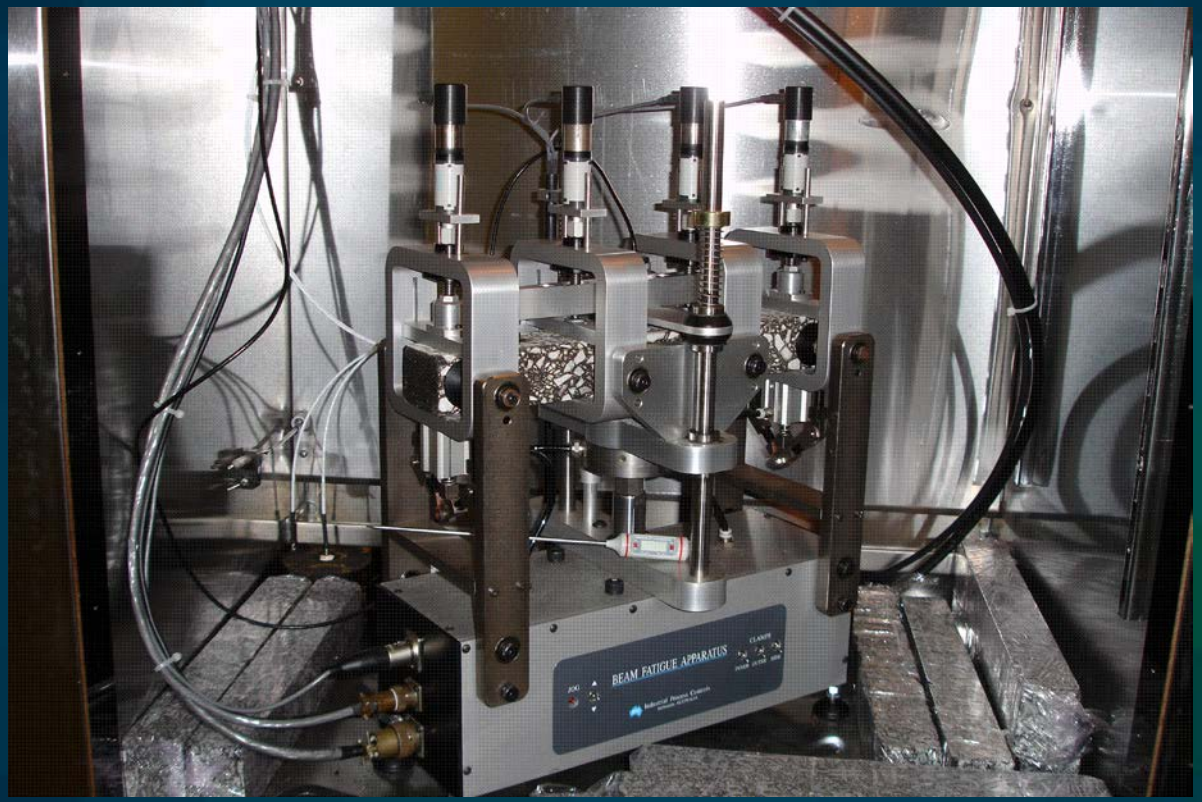
Performance Testing of the HPTO Mix

- **Laboratory Testing**
  - **Rutting**
    - **Asphalt Pavement Analyzer (APA)**
  - **Fatigue Cracking**
    - **Flexural Beam Fatigue Device**
  - **Reflective Cracking**
    - **Texas Overlay Tester**
  - **Permeability**
    - **Flexible Wall Permeability Tester**
  - **Skid Friction**
    - **Skid Trailer**

Asphalt Pavement Analyzer Results – Test Project

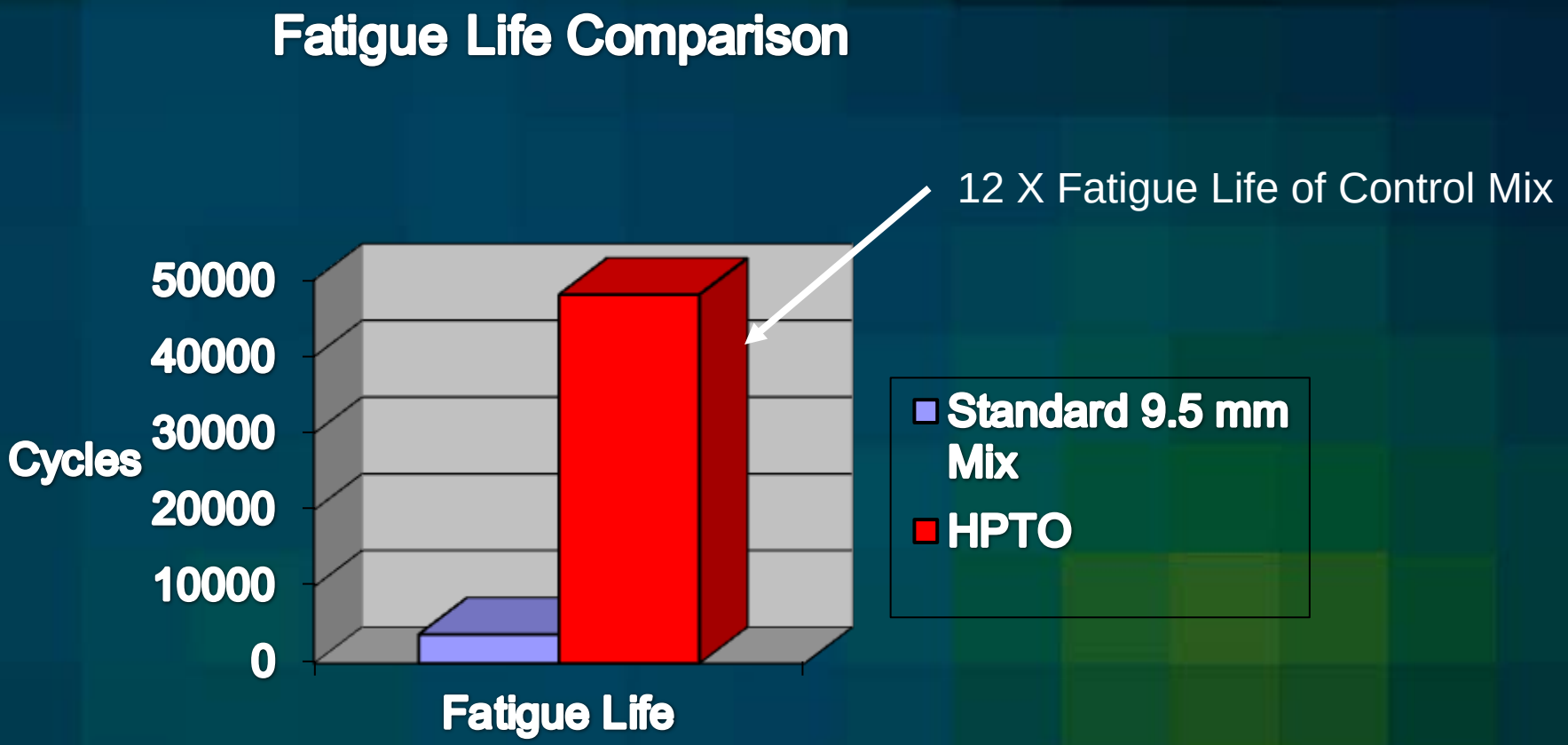


Performance Testing of the HPTO Mix



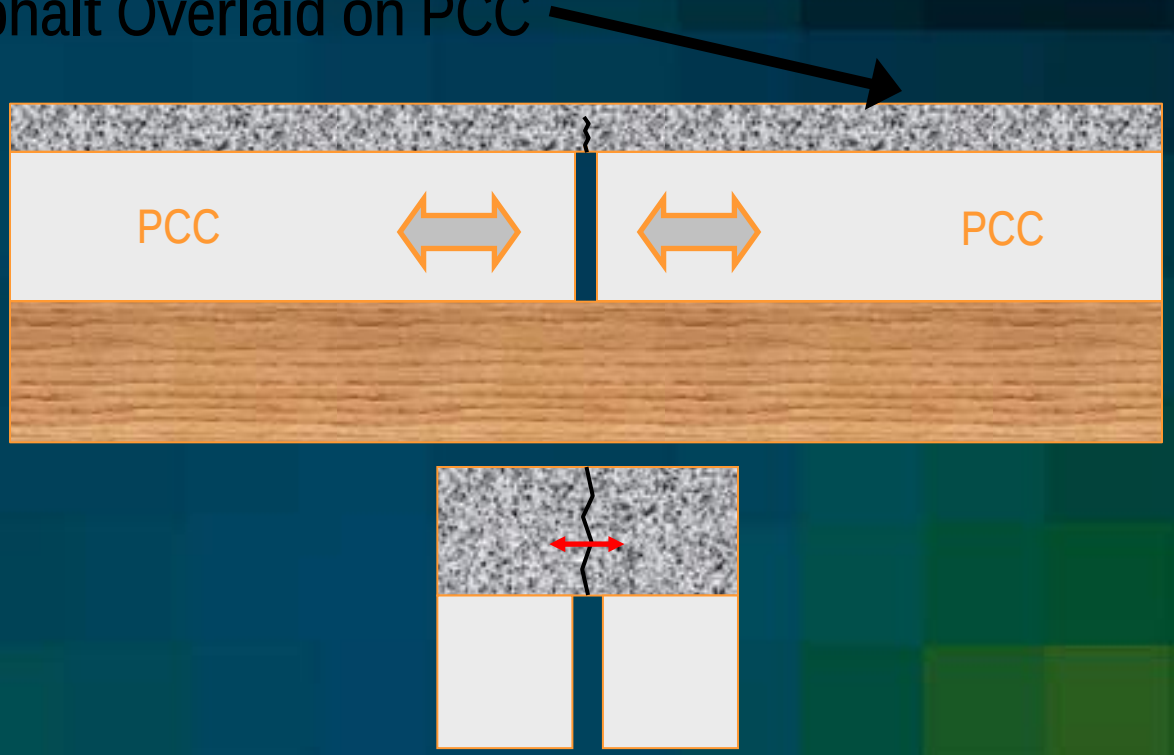
- **Flexural Beam Fatigue Testing**
  - **Measure number of cycles to failure**

Flexural Beam Fatigue Results – Harford County Project



Climatic Loading – Horizontal Movement

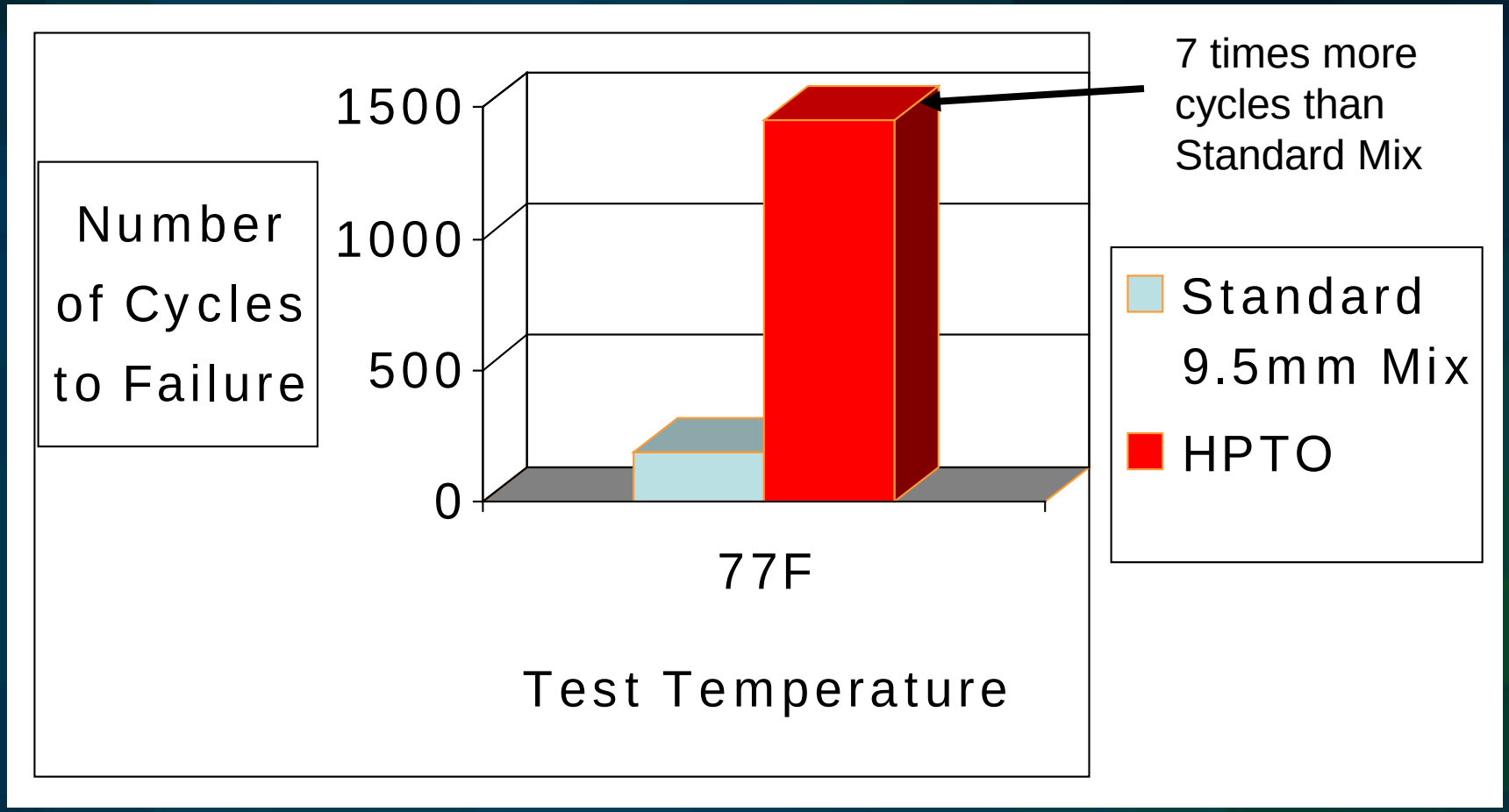
Hot Mix Asphalt Overlaid on PCC



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

Horizontal Stress/Strain is modeled using Overlay Tester

Overlay Tester Results – Harford County Project



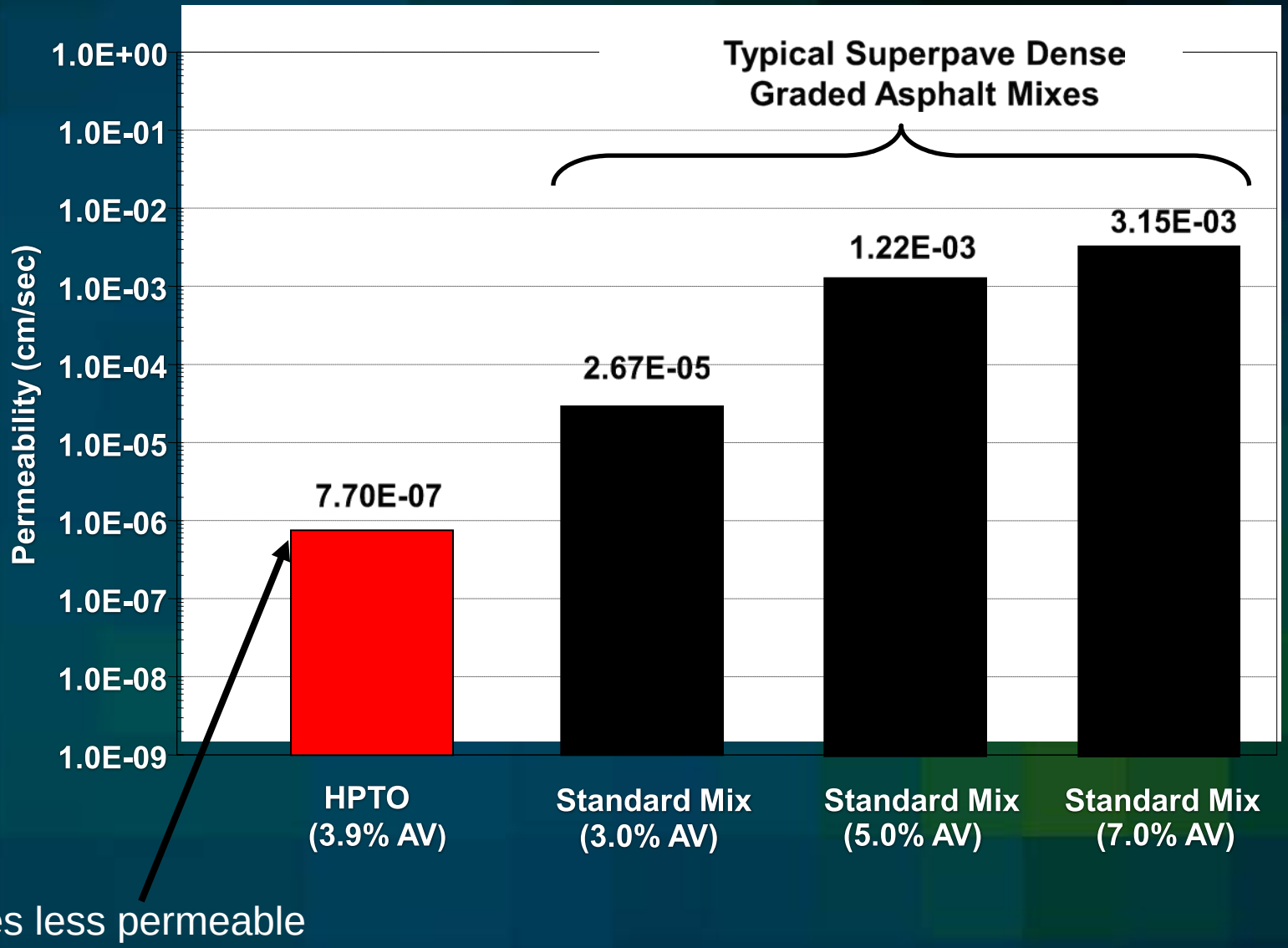
Texas DOT requires minimum of 300 cycles to pass the test

Flexible Wall Permeability Testing

- **For Pavement Preservation, important to “seal” pavement to limit moisture**
- **Permeability on order of a silt/clay, required testing in “Flexible Wall” Permeability Set-up**

Samples cored from 6-inch diameter gyratory sample

Typical Permeability Values



Surface (Skid) Friction, SN_{40}

Material Type	Skid Number
HPTO	53
9.5 mm Mix (New)	51.6
9.5 mm Mix (4 Yrs)	54.3
19mm Mix (4 Yrs)	55.7
19mm Mix (5 Yrs)	47.7

DOT Application for Interstate & Primary Roads

- **Material needed for ‘intermediate’ maintenance application (one that extend pavement life but without impact on existing clearances)**
- **Prefer to use a ‘non-proprietary’ product**
- **HPTO can be a solution**

NJ DOT HPTO Materials

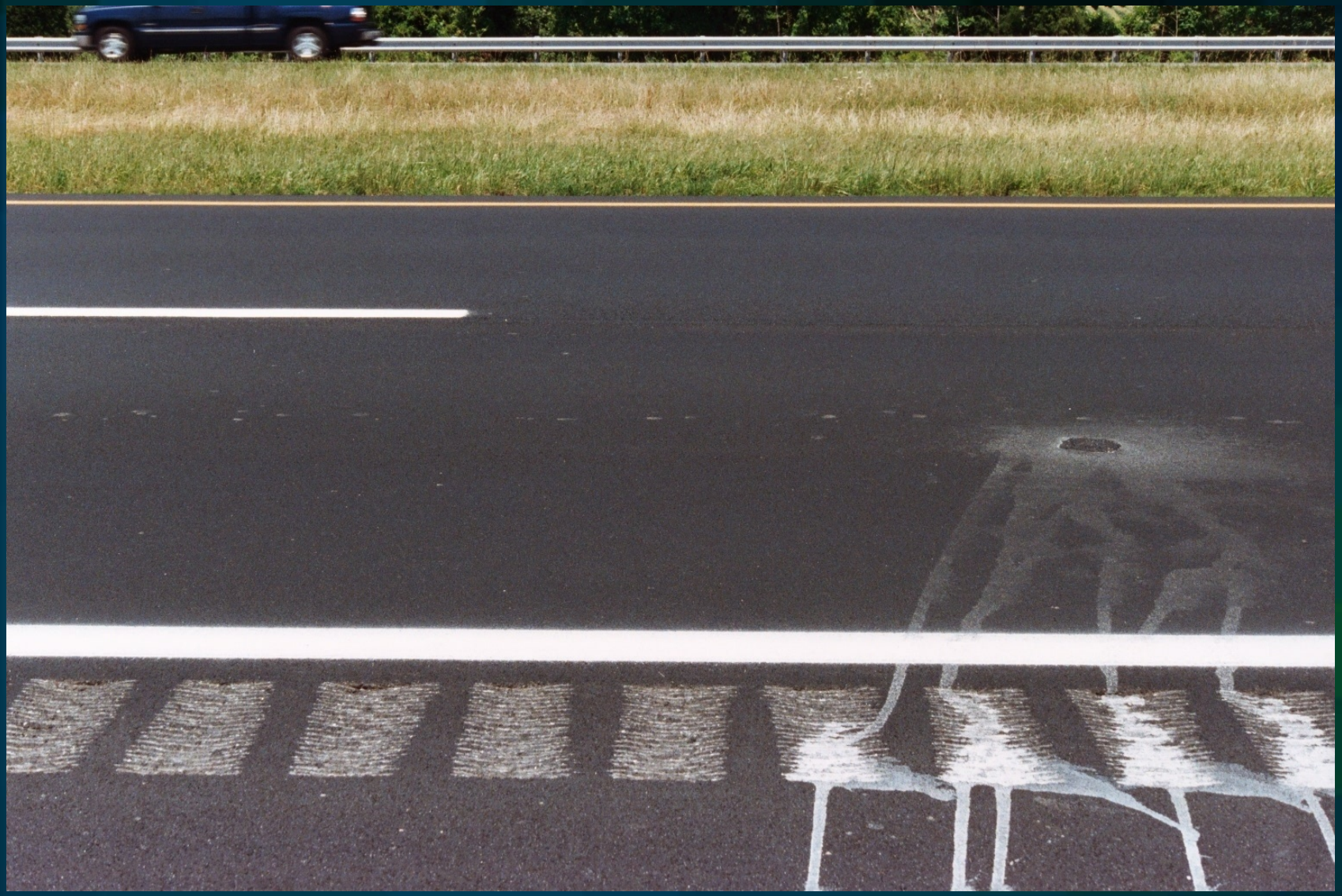
- New Jersey requirements
  - Thin-lift ≤ 25mm thick (Ideally)
    - eliminate change to existing infrastructure (bridge clearances, drainage, etc.)
  - Minimal Impact to Users (Coverage vs. Unit Time)
  - Re-new and upgrade road surface (Ride Quality - serviceability)
  - No “Cure-time” dependent materials
  - Must withstand high stresses

NJDOT HPTO - Specification

Sieve Size		Percent Passing		
		HPTO	NJ HPTO	NJ 9.5 mm (I-5)
12.5 mm	½”	100	100	100
9.5 mm	3/8”	100	100	95
4.75 mm	#4	65-95	65-85	60
2.36 mm	#8	35-55	33-55	42
1.18 mm	#16	20-35	20-35	32
0.60 mm	#30	15-30	15-30	24
0.30 mm	#50	10-20	10-20	15
0.075 mm	#200	4-10	5-8	6.3
Binder Type		HPTO XP	PG 76-22 (PMA)	PG 64-22
Minimum AC%		7.0%	7.0%	5.1
% Air Voids		3.0%	3.5%	4.0
VMA		> 18%	> 18%	16.3
SGC N_{des}		50	50	75
APA Rutting		Max. 5 mm	Max. 4 mm	

NJ I-295 HPTO Project

NJ I-295 HPTO Project



NJ I-295 HPTO Project

NJ I-280 HPTO-WMA

- **Application- 1.25” overlay over PCC**
- **HPTO with PG 76-22 binder**
- **Construction scheduled for November**
- **DOT concern – overheating of PMA mix**
- **Try WMA for late season paving**
- **Normally run at 340F – with WMA ran at 290F**

NJ I-280 HPTO-WMA

- **Placed +10,000 tons in 9 days**
- **Used WMA binder additive Evotherm 3G**

NJ I-280 HPTO-WMA

- **Average of 9 lots:**
- **5.0 in-place % air voids**
- **1.7” thickness**
- **Highest AV = 6.0%**
- **Lowest AV = 3.9%**

NJ I-280 HPTO-WMA

HPTO / HPTO System Summary

- Can be designed for county / municipal roads as well as Interstate highways
- Based on lab tests & project performance to date – should provide longer life than conventional mix (9.5mm)
- User friendly - local materials and contractors
- Cost effective alternative to “mill & fill”
- Good performance to date for state agencies with PMA
  - Ohio DOT
  - NJ DOT – HPTO
  - NYSDOT – 6.3 mm mix

Questions?