The Development and Use of High Performance Thin Overlay Systems

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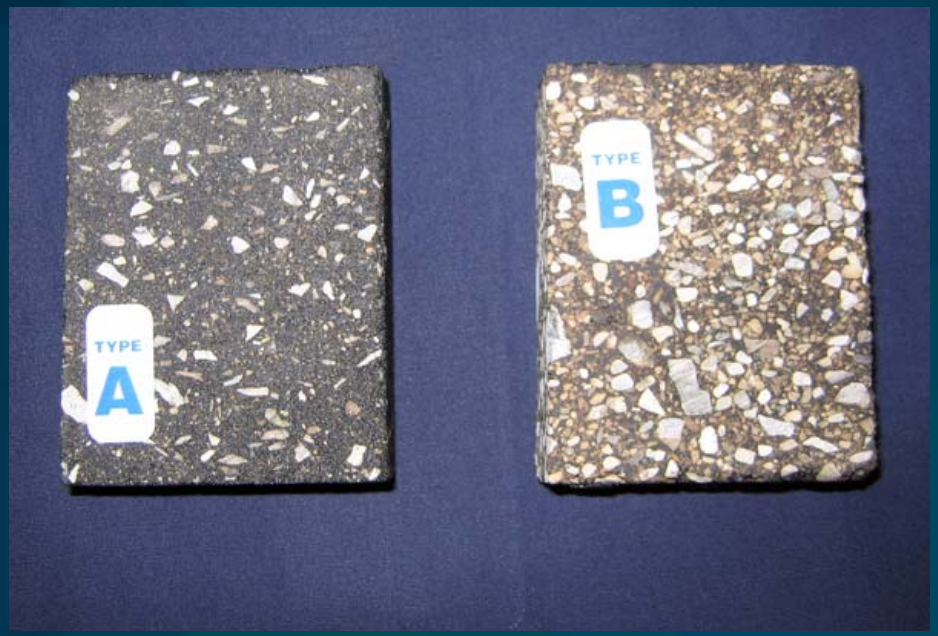
HMA Thin Surface Mixes

- 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 1973
  - 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)

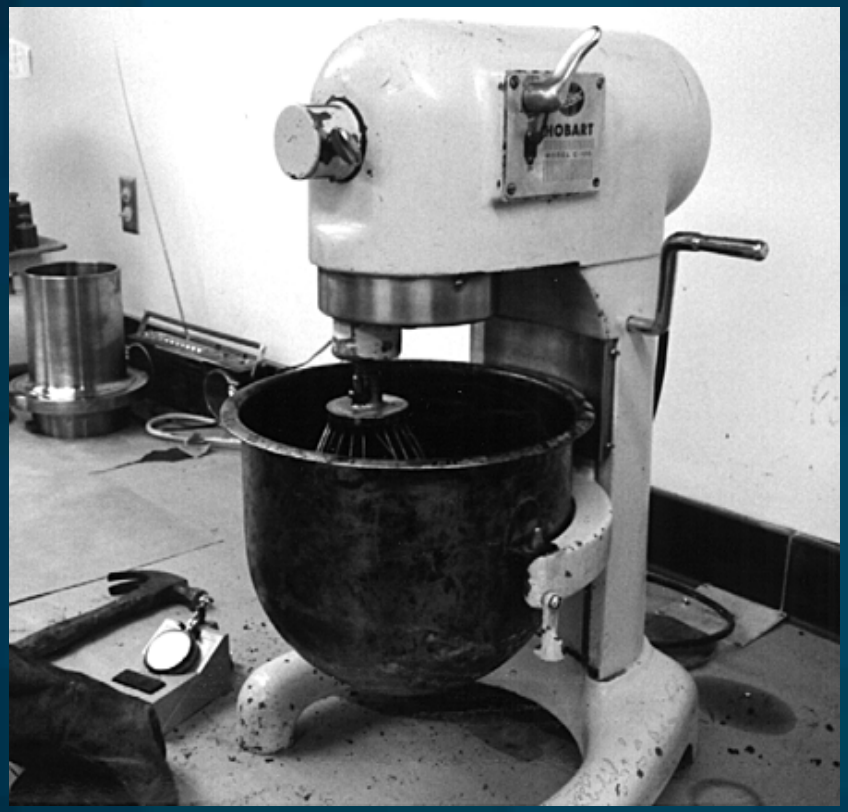
HMA Thin Surface Mixes

- 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

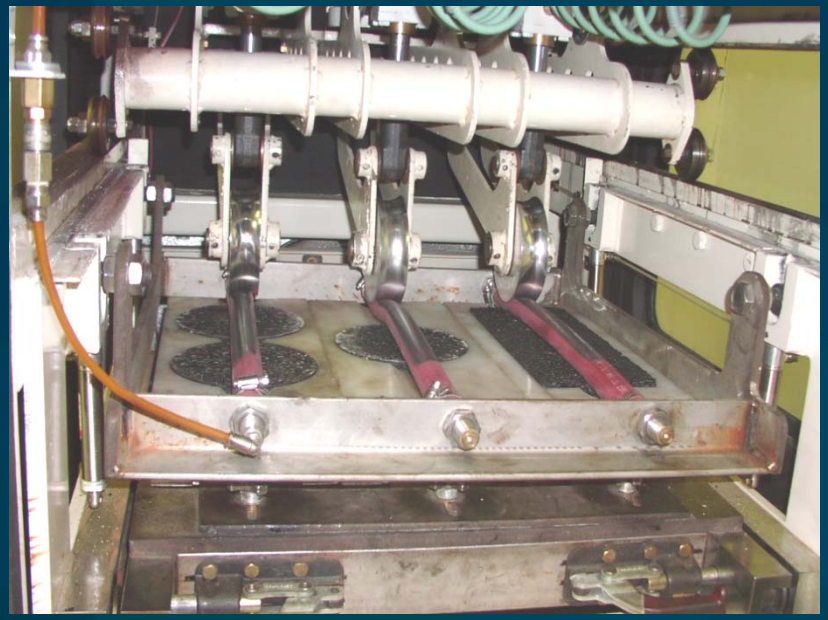
Local Use

DOT Use

Development of the FlexGard 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 FlexGard System

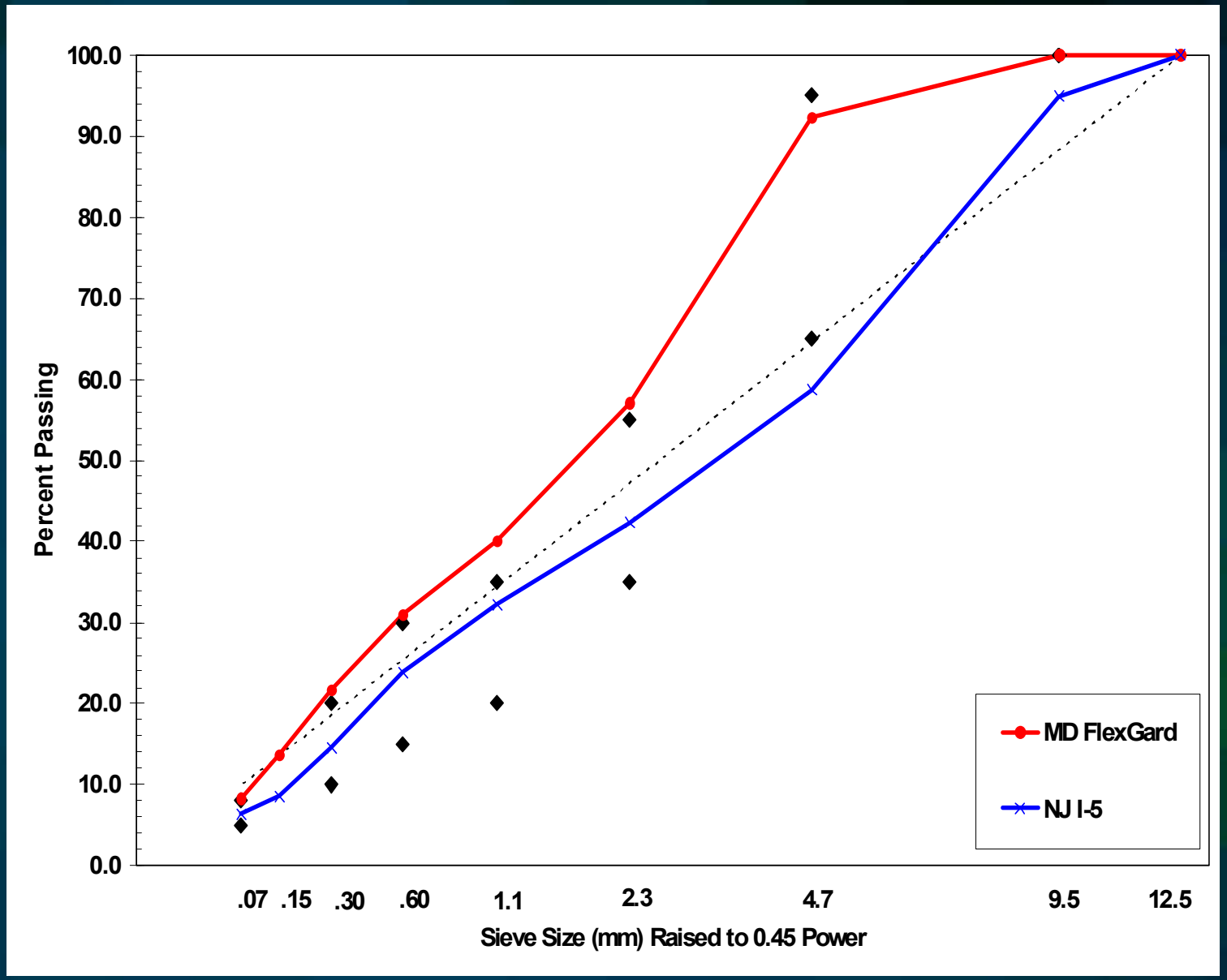


- **Achieving Research Objectives**
  - **Rutting Performance**
    - **Quality aggregates**
    - **Good aggregate gradation**
    - **Specially Engineered Polymer-Modified Asphalt (PMA)**
    - **Mix performance test (APA, Hamburg, AMPT)**

Development of the FlexGard 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 FlexGard 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 FlexGard System

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

Initial Installation of the FlexGard

- **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 FlexGard 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 FlexGard System

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

Initial Installation of the FlexGard System

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

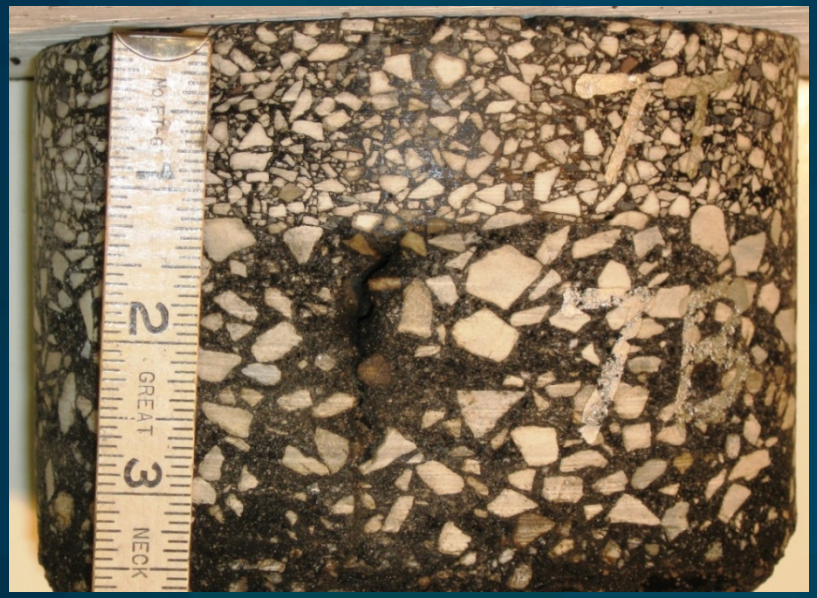
Initial Installation of the FlexGard System

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

Paulsboro FlexGard – Pavement Evaluation

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

Paulsboro HPTO - Cores



Paulsboro HPTO – after 3 years

Paulsboro HPTO – 3 years old

Original

After 3 years

Harford County FlexGard Project

Harford County FlexGard Project

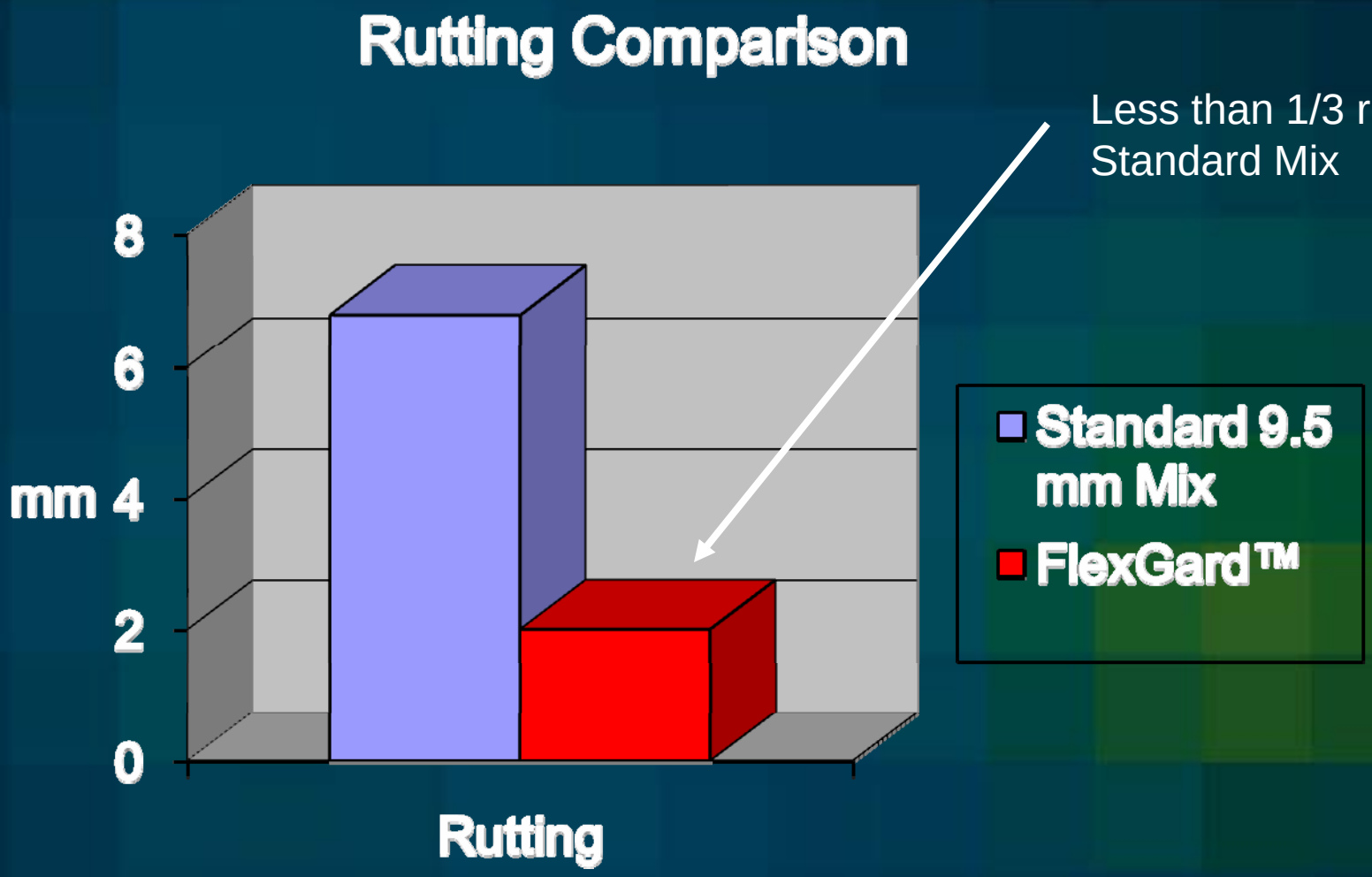
Harford County FlexGard Project

Harford County FlexGard Project

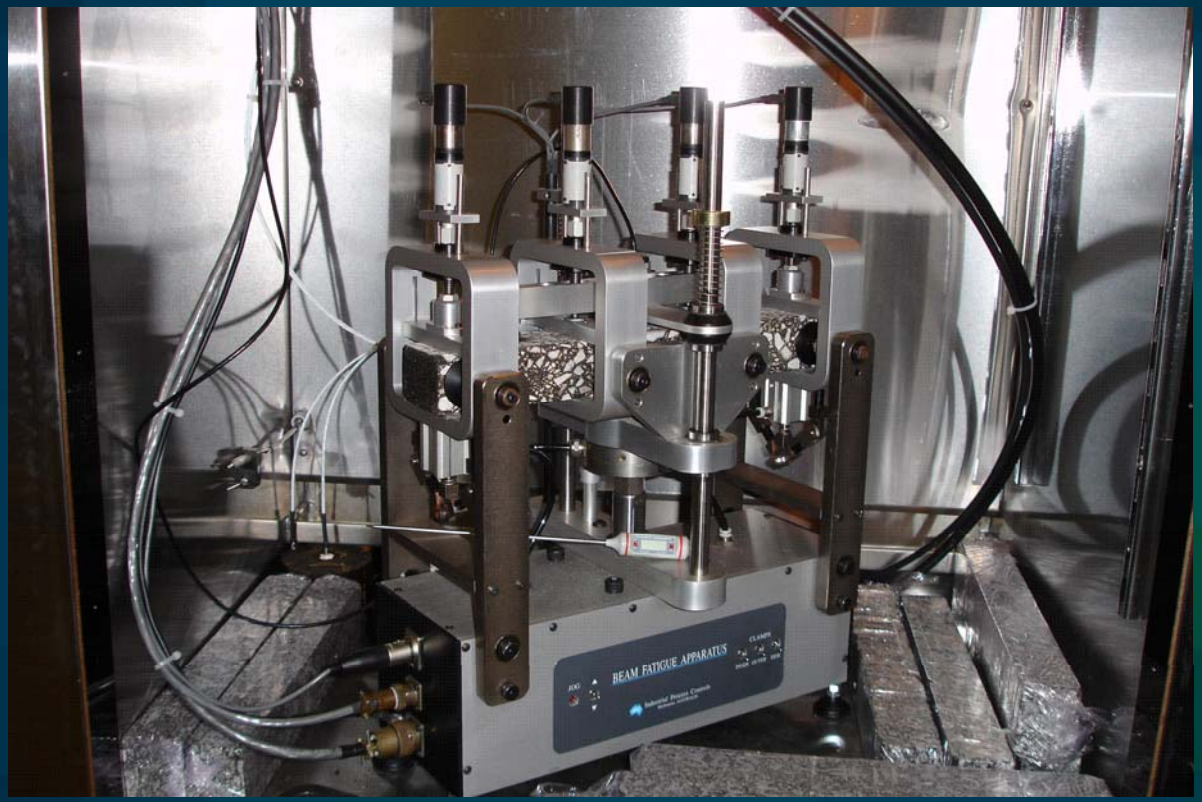
Performance Testing of the FlexGard Mix

- 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

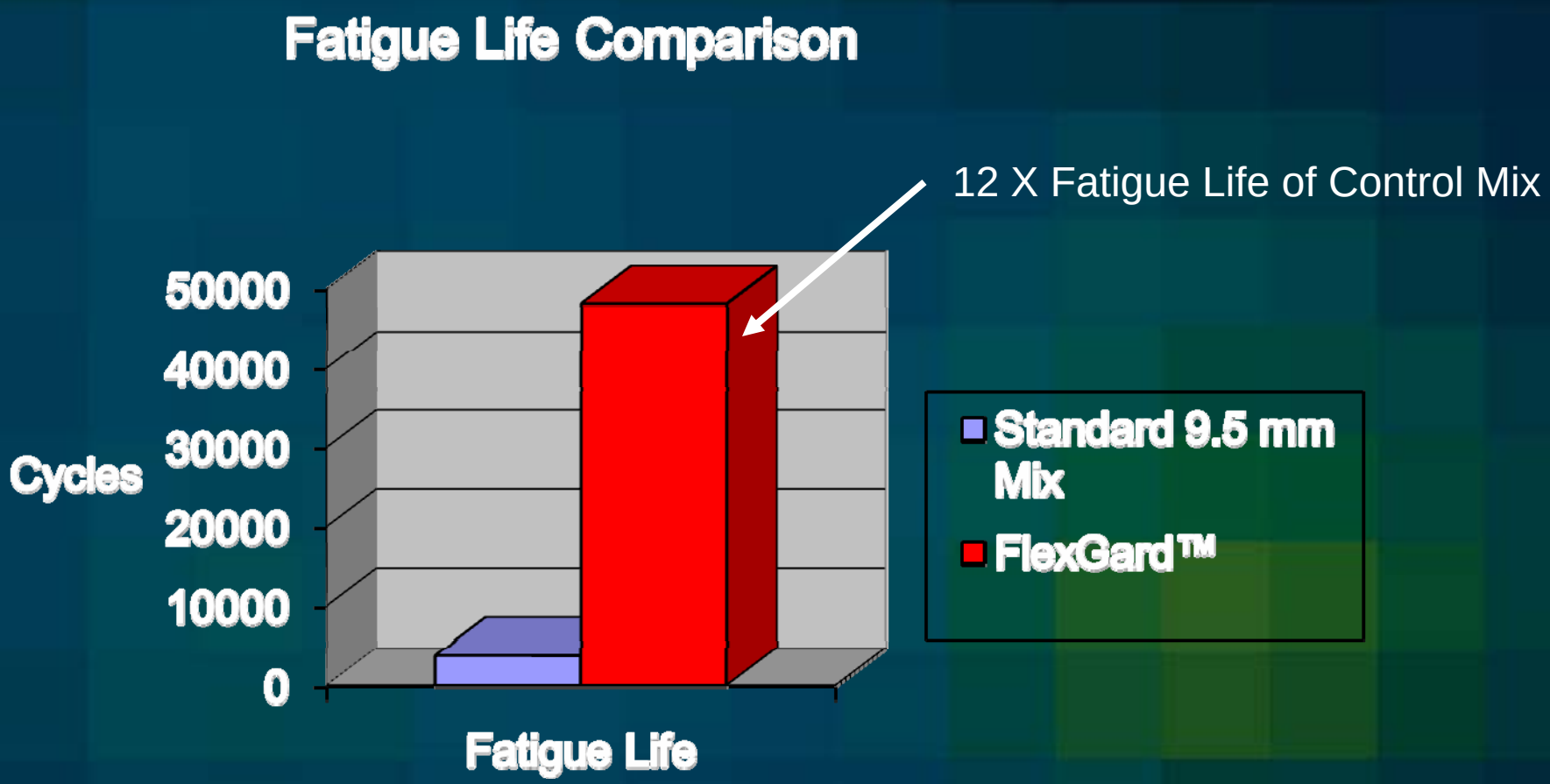


Performance Testing of the FlexGard Mix



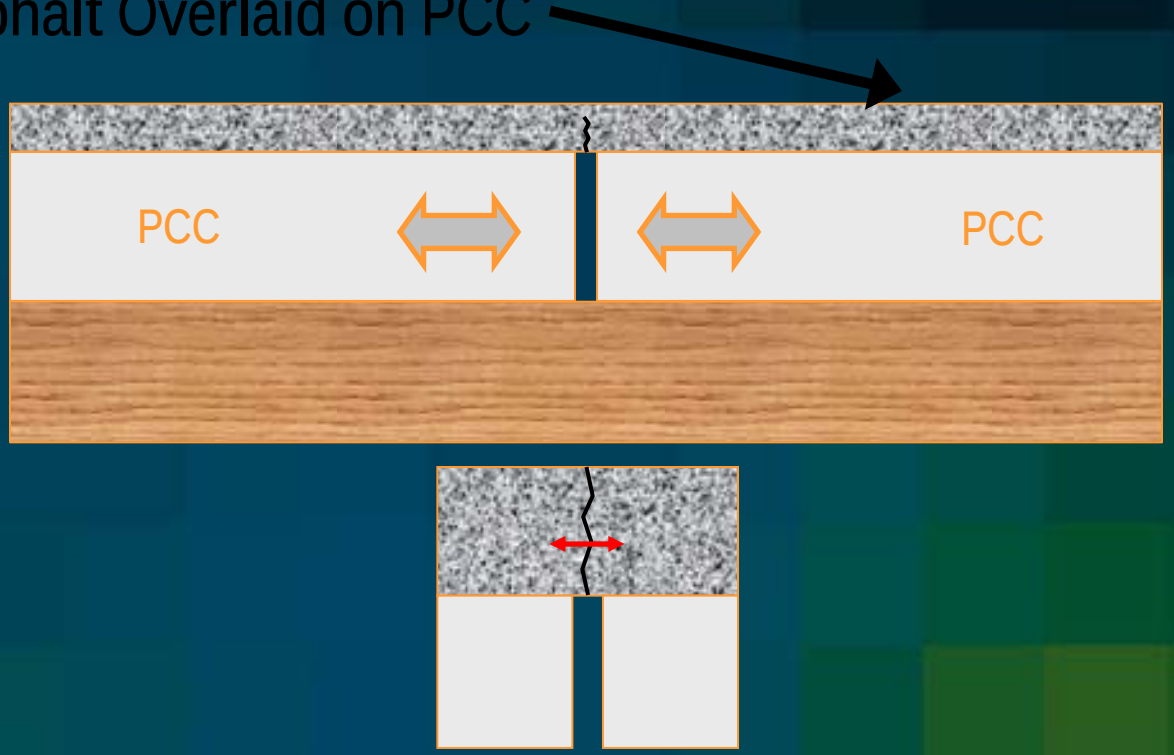
- **Flexural Beam Fatigue Testing**
  - **Measure number of cycles to failure**

Flexural Beam Fatigue Results – Harford County Project



Climatic Loading – Horizontal Movement

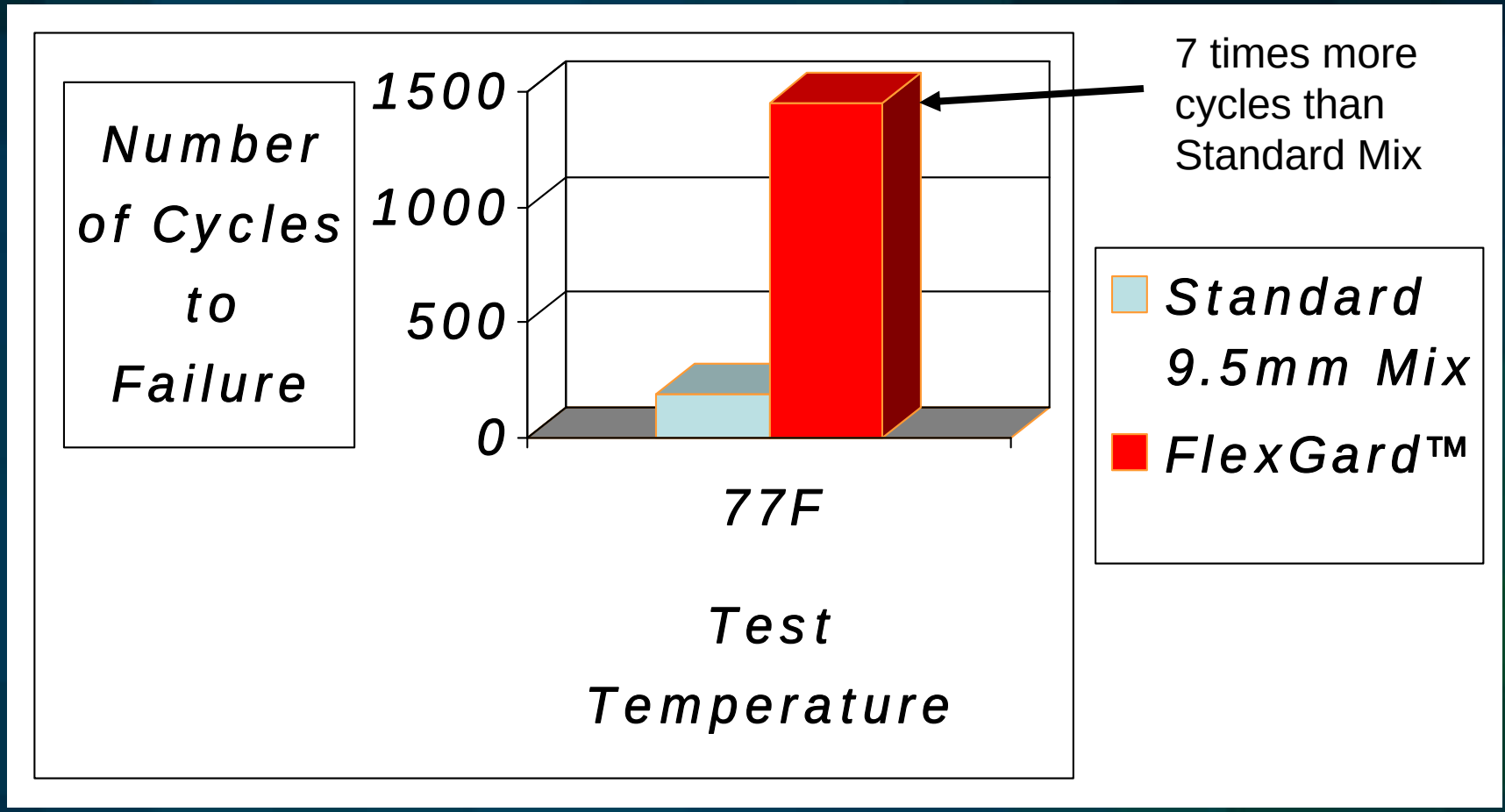
Hot Mix Asphalt Overlaid on PCC



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



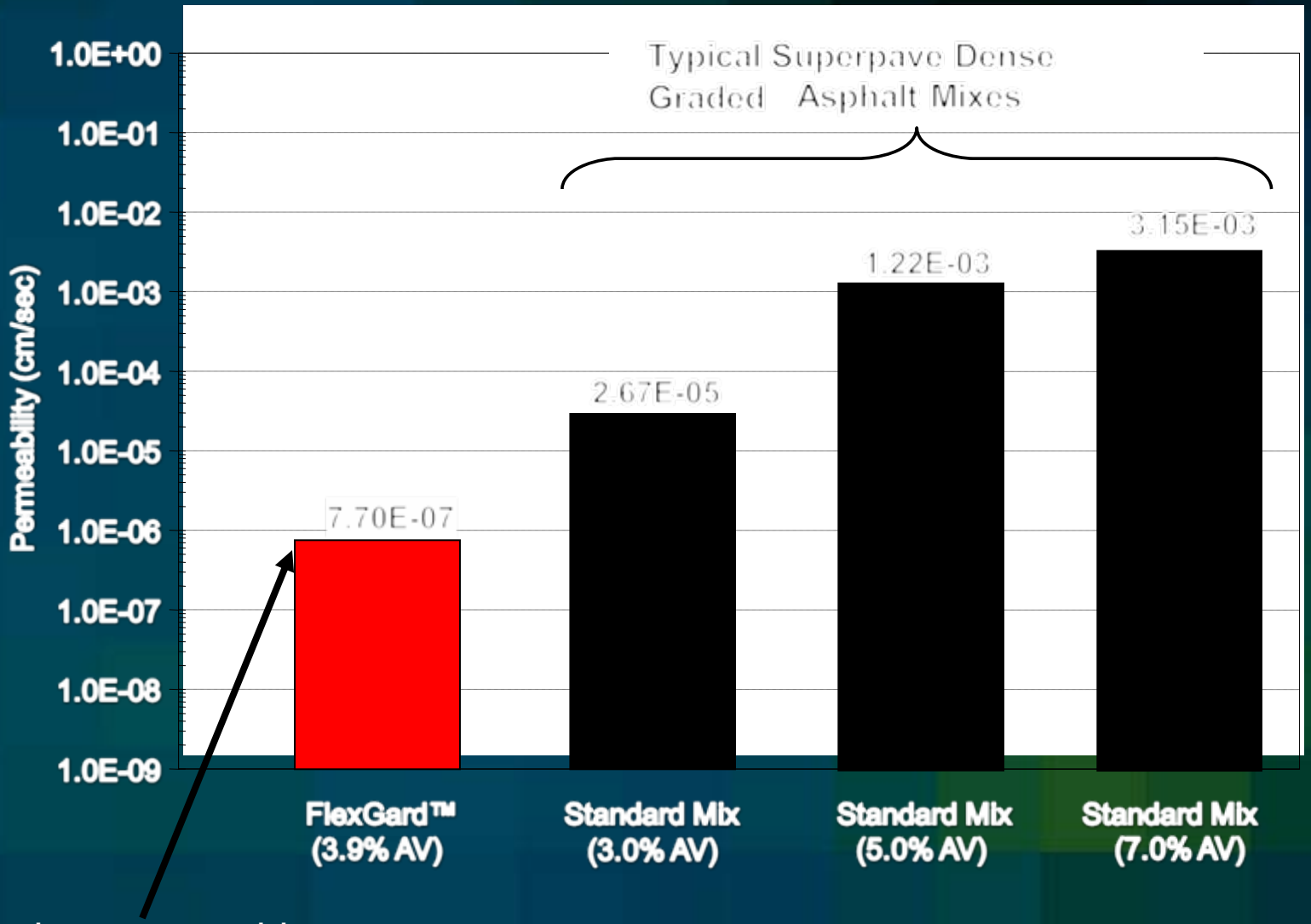
Texas DOT requires minimum of 300 cycles to pass the test

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



100 times less permeable

Surface (Skid) Friction, SN_{40}

Material Type	Skid Number
FlexGard™	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

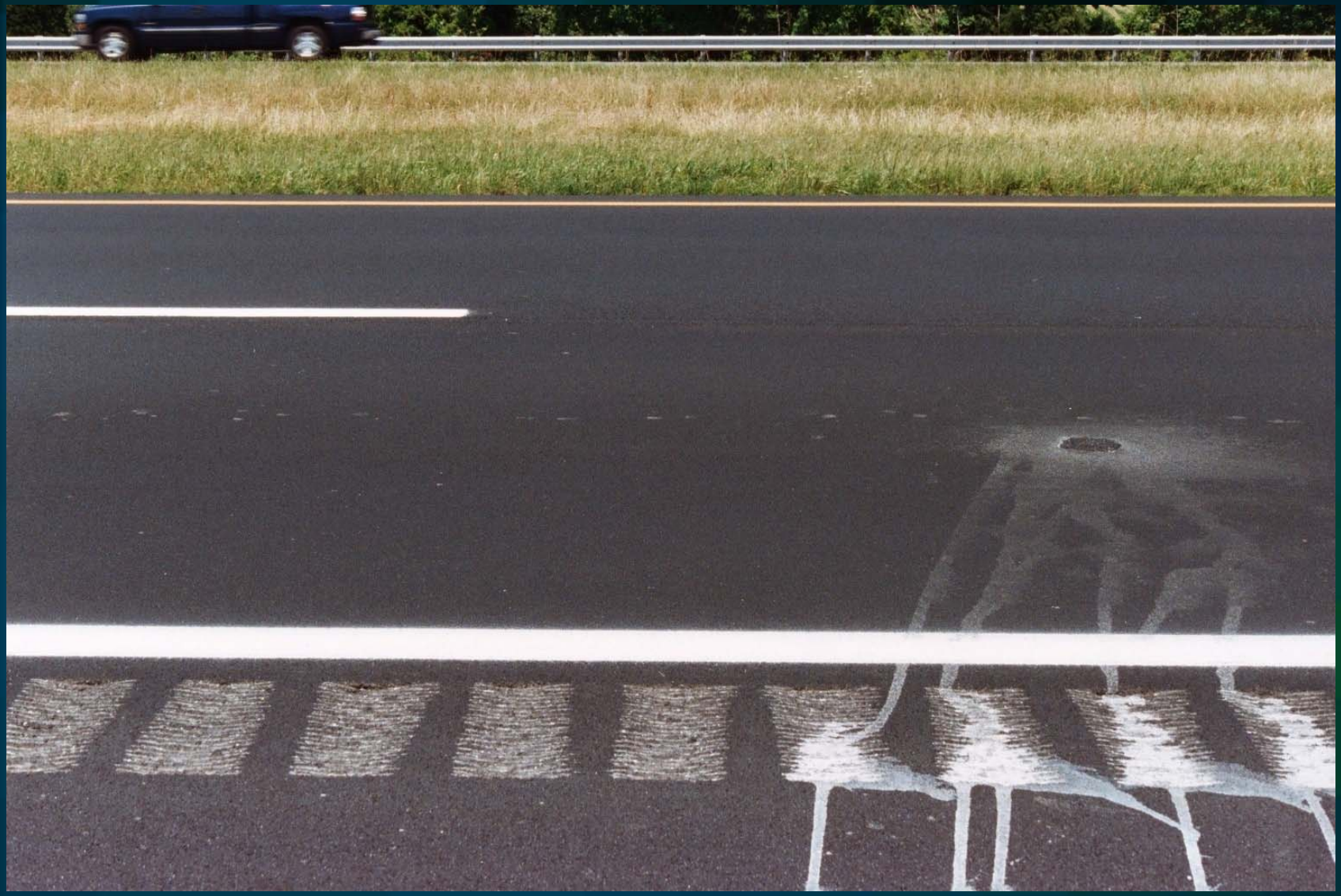
- New Jersey requirements
  - Thin-lift ≤ 25mm thick (Ideally)
    - eliminate change to existing infrastructure (bridge clearances, drainage, etc.)
  - Minimal Impact to Users (Coverage vs. Unit Time)
  - Re-new and upgrade road surface (Ride Quality - serviceability)
  - No “Cure-time” dependent materials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

NJDOT HPTO - Specification

Sieve Size		Percent Passing		
		FlexGard	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		FlexGard 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

FlexGard / 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?