The Development and Use of High Performance Thin Overlay Systems for NYC DOT

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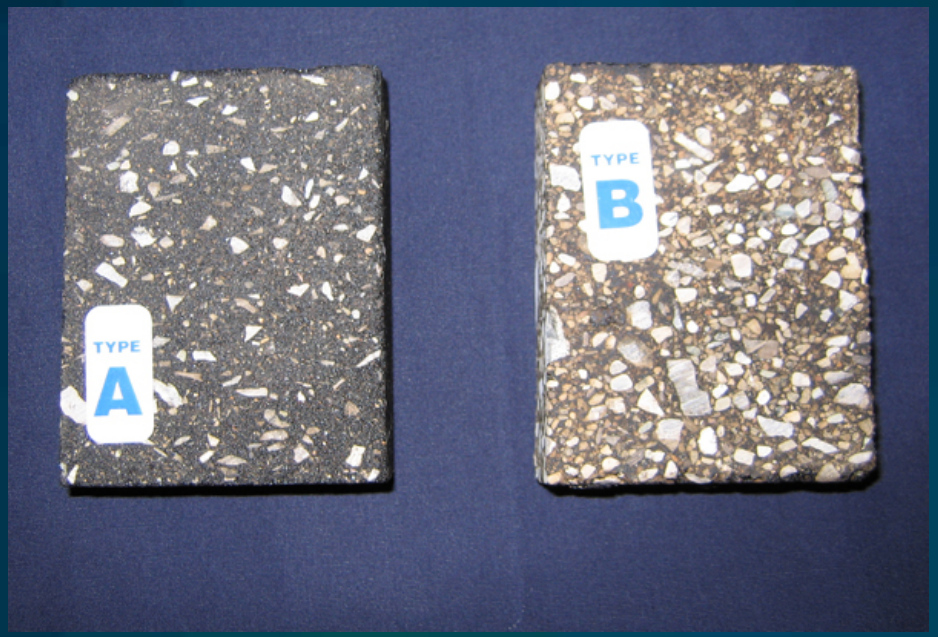
HMA Thin Surface Mixes

- **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



- **Ohio DOT**
  - **Smoothseal thin lift mix**
  - **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**

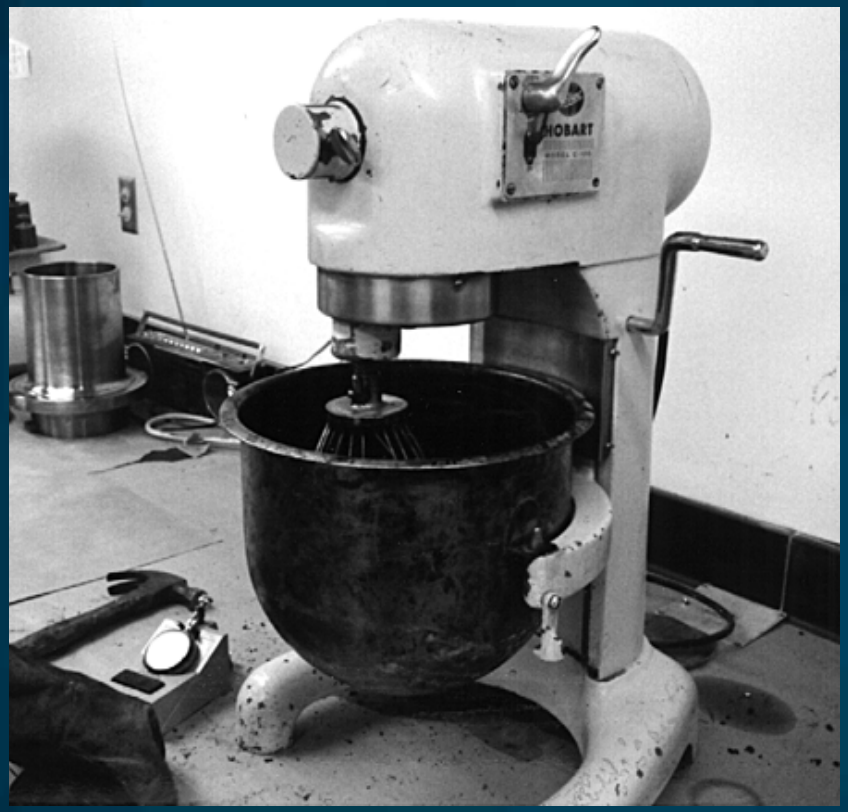
HMA Thin Surface Mixes

- **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

- **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

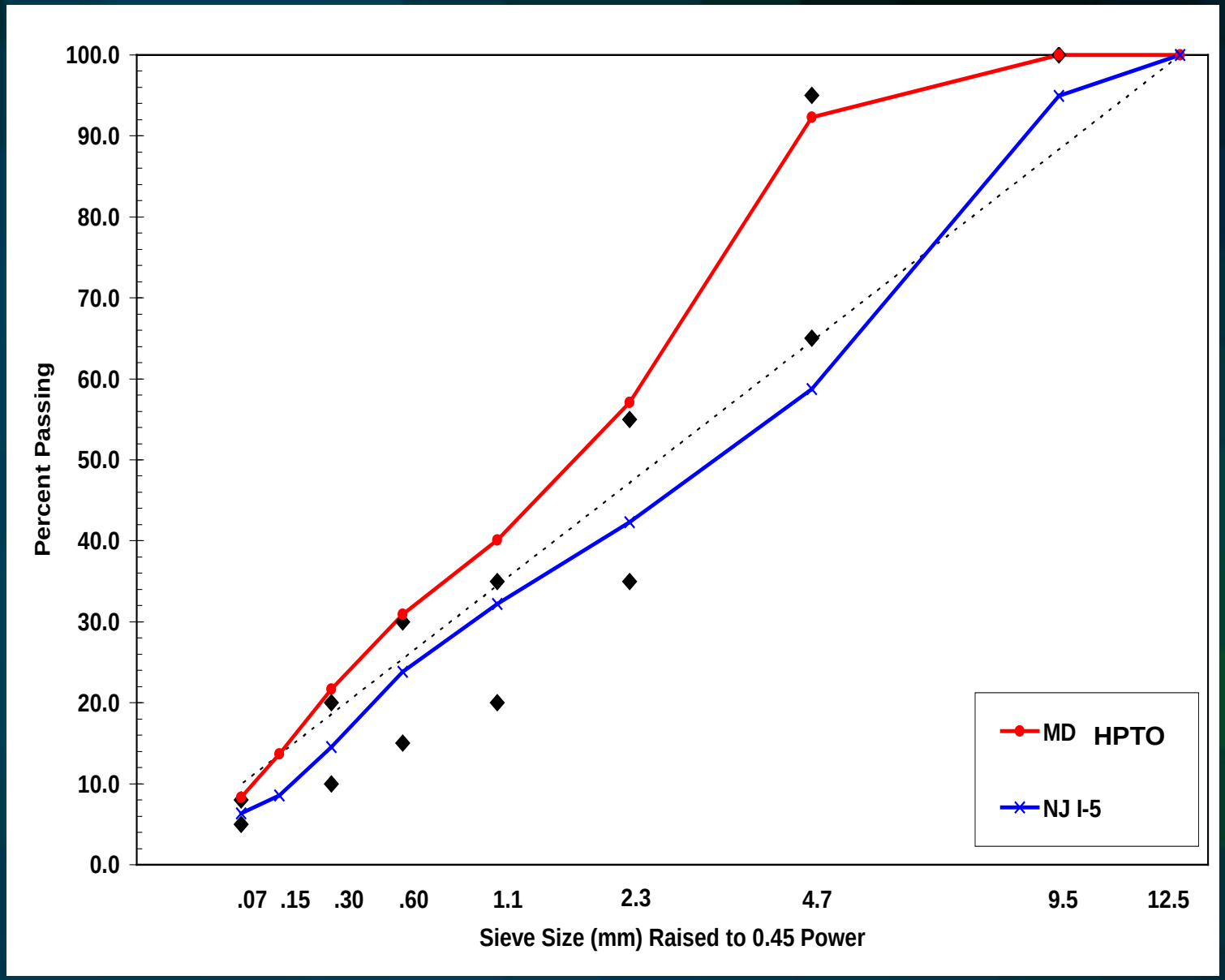


- **Requirements**
  - **Improve Durability**
    - **Higher AC/ film thickness mix (VMA)**
    - **Dense / non-segregating mix (in-place density)**
  - **Rut & Crack Resistant**
    - **PMA Binder**
    - **High quality aggregates**
    - **Mix performance test**

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	

HPTO & 9.5 mm Mix Gradation Plot



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**

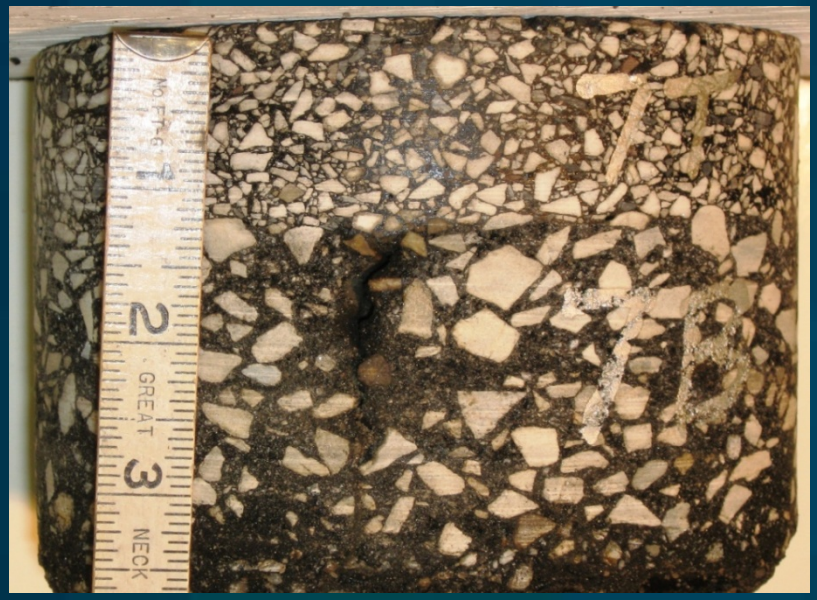
Paulsboro HPTO – 3 years old

Original

After 3 years

Paulsboro HPTO – after 3 years

Paulsboro HPTO - Cores



NJ I-295 HPTO Project

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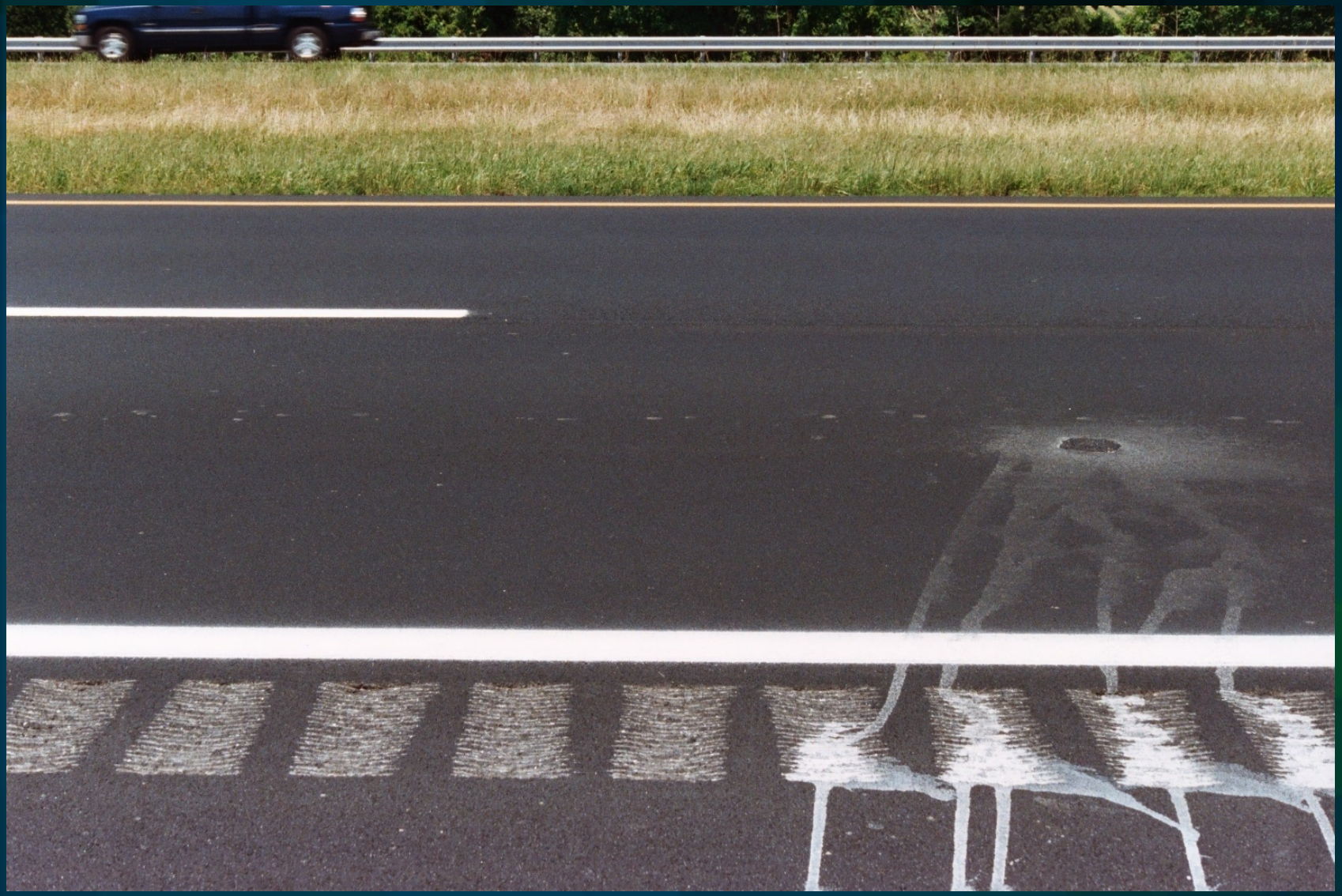

NJ I-295 HPTO Project

HPTO Mix in NYC

- 1st Avenue in Manhattan is 20-25 year old 18” thick PCC pavement
- Steam line beneath the pavement
- Removing the PCC would most likely damage the steam line
- Funding not available to replace PCC pavement and the steam line

HPTO Mix in NYC

- PCC pavement is in poor condition
- Curb clearances prevent use of a thick overlay
- NYC is attempting to improve bus service with an new bus lane on 1st Avenue
- High Performance Thin Overlay selected as rehabilitation strategy

HPTO Mix in NYC

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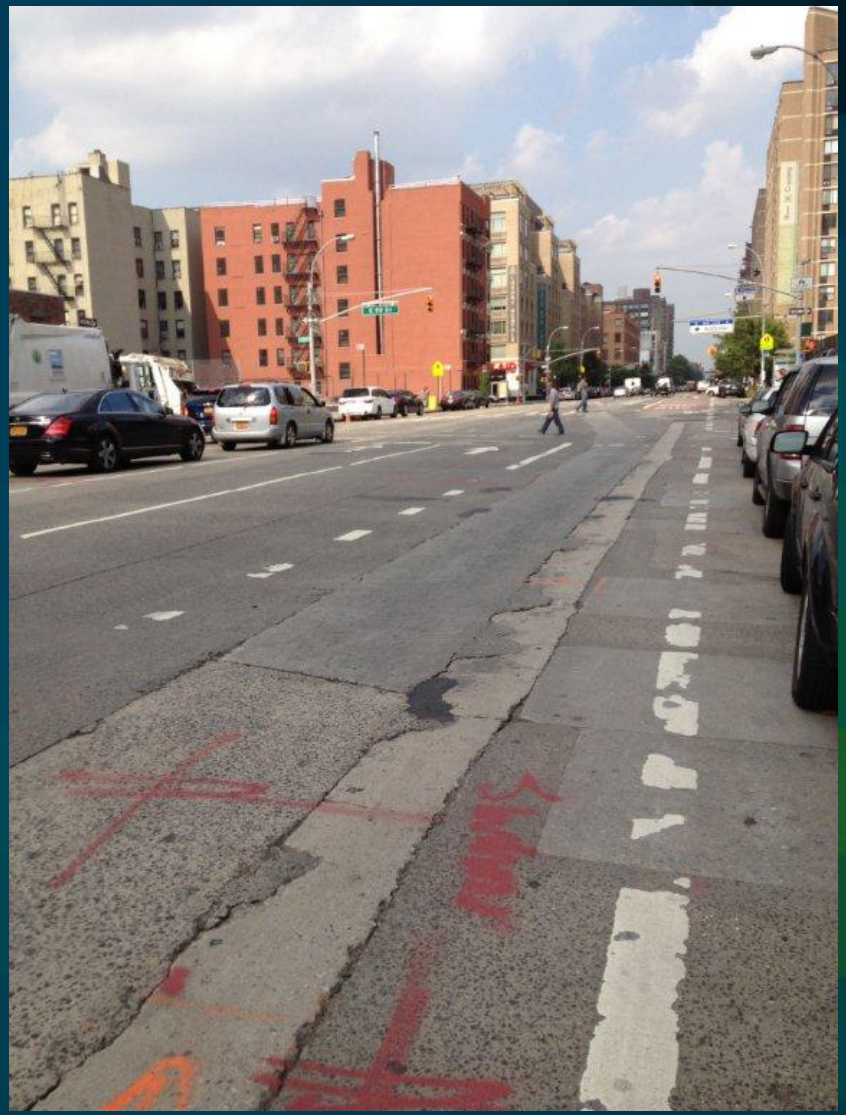


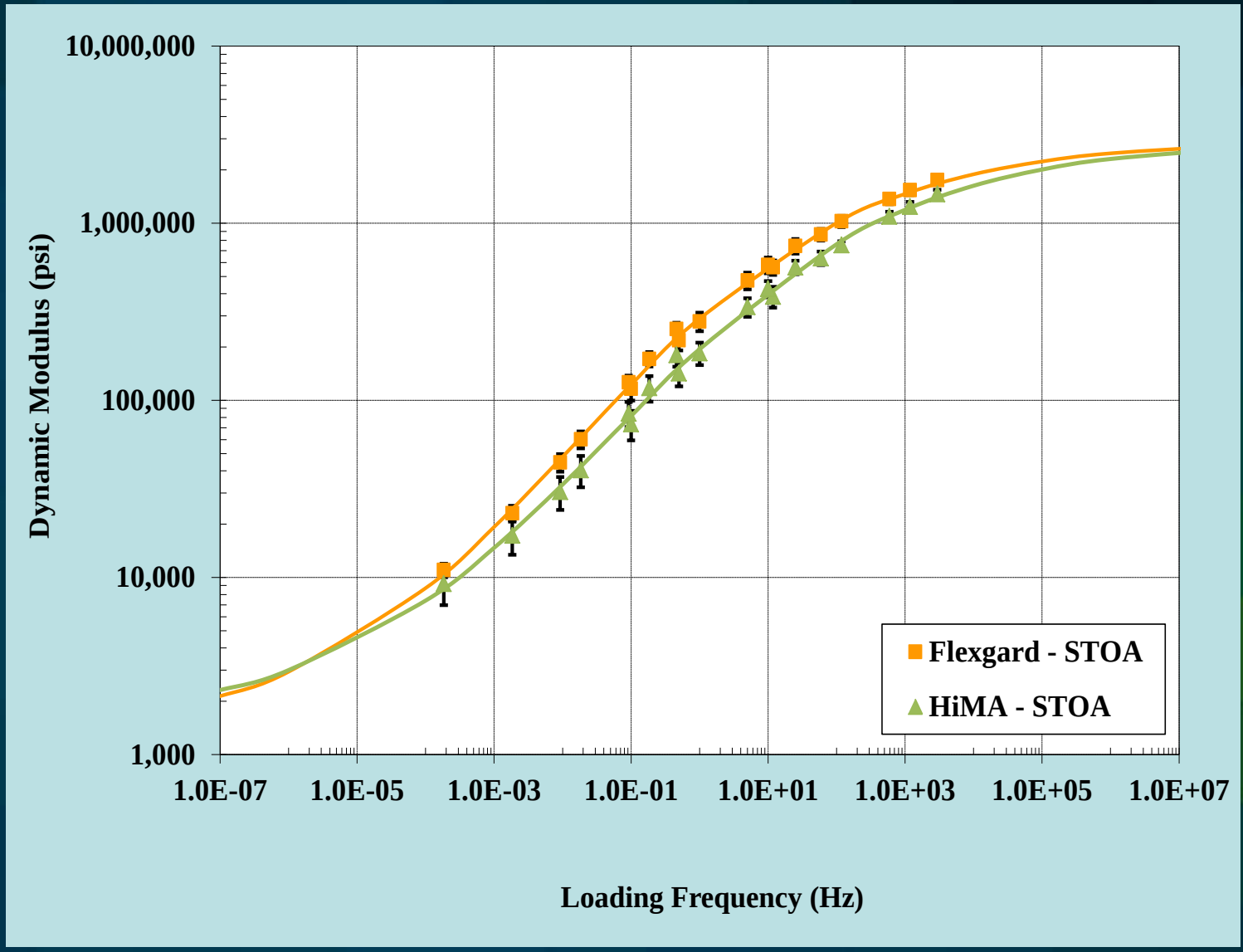
HPTO Mix in NYC

- **Research at Rutgers University comparing HPTO mix with conventional PMA binder and Highly Modified Asphalt (HiMA)**
- **HiMA developed by Kraton Polymers**
  - **SBS with lower viscosity increase**
  - **7.5% polymer loading**

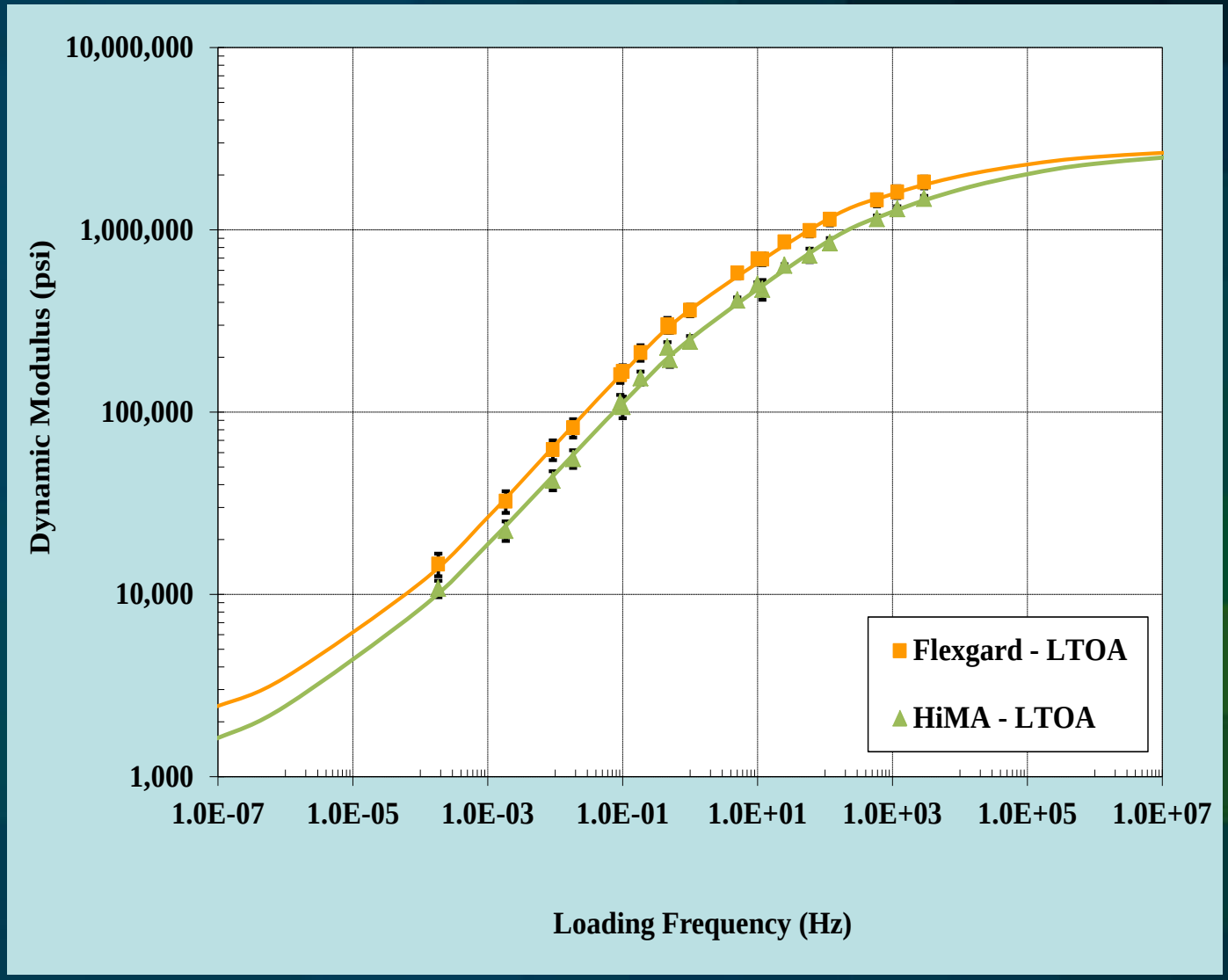
HPTO Mix in NYC

- **Conventional PMA binder had continuous grade of PG 80.4-27.3**
- **HiMA binder had a continuous grade of PG 82.5-32.73**

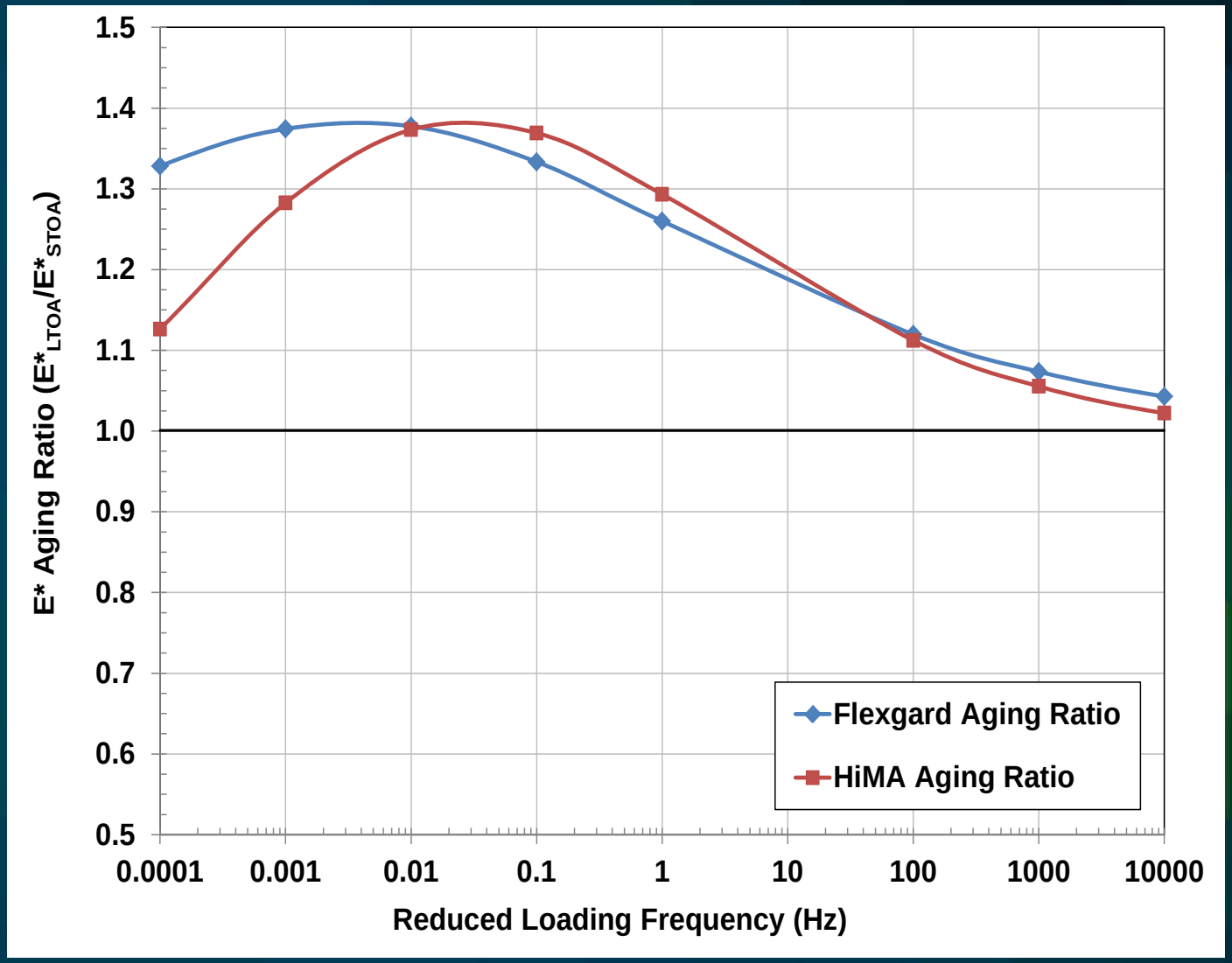
Dynamic Modulus Master Curve - STOA



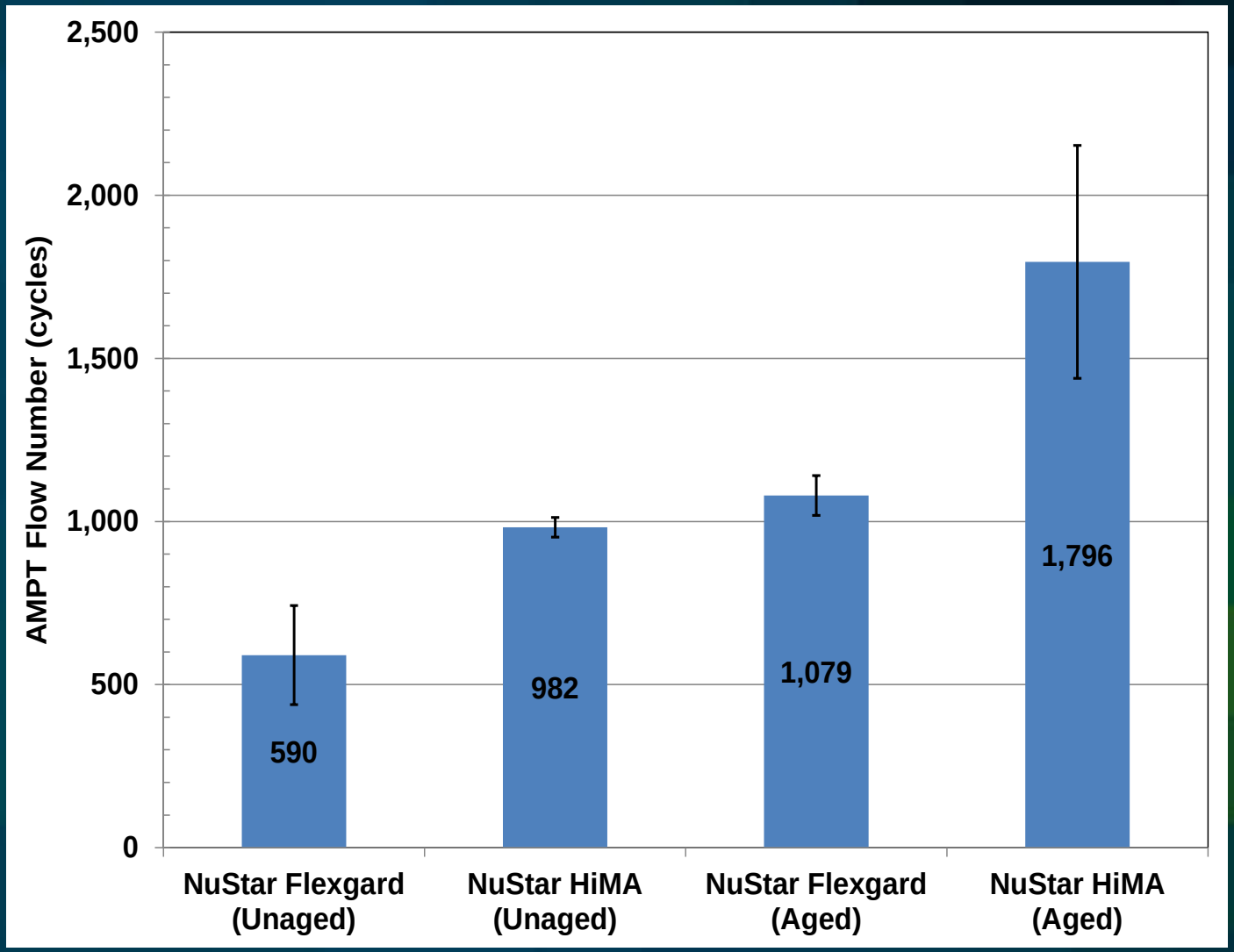
Dynamic Modulus Master Curve - LTOA



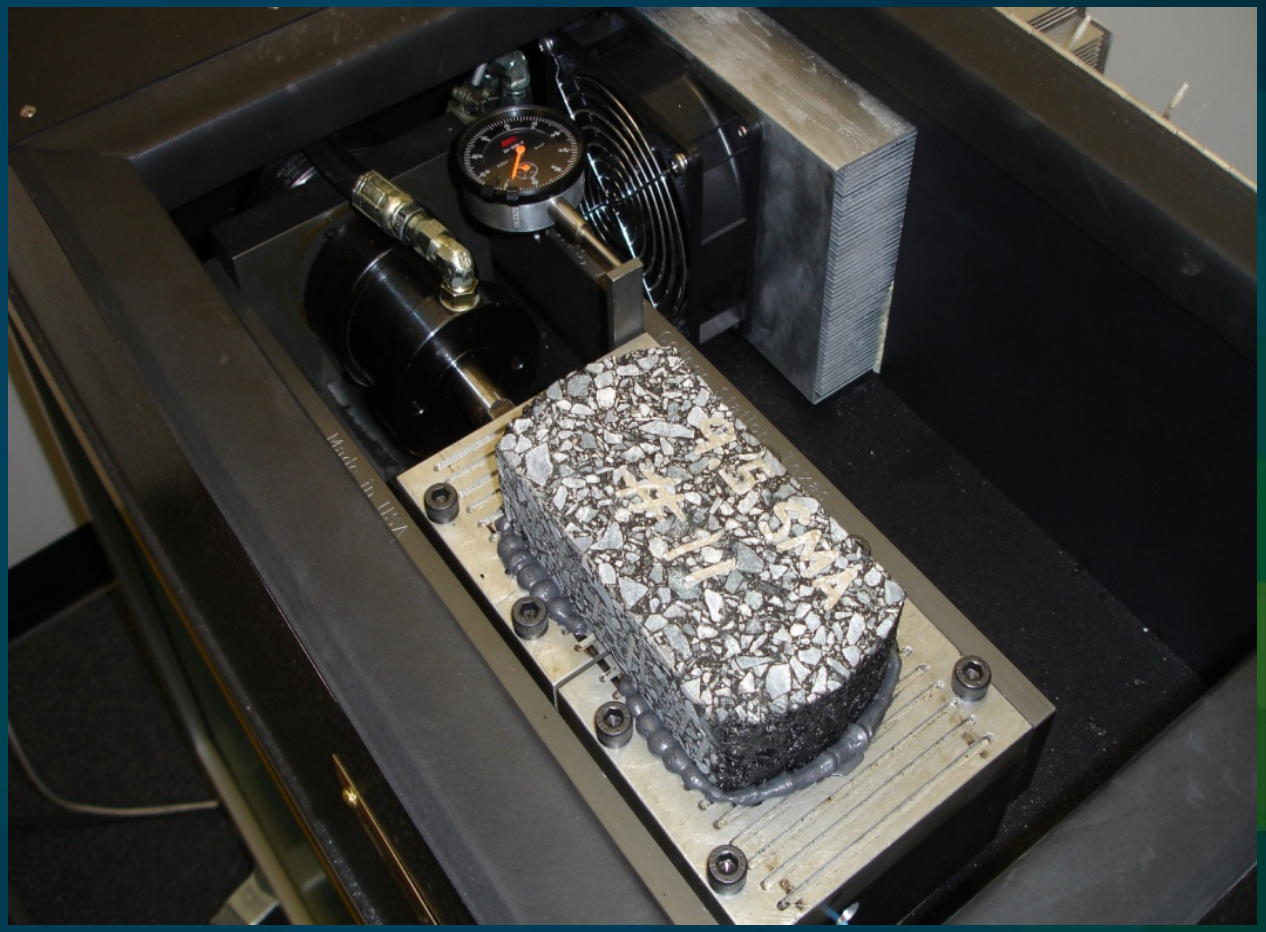
Dynamic Modulus Aging Ratio



Flow Number

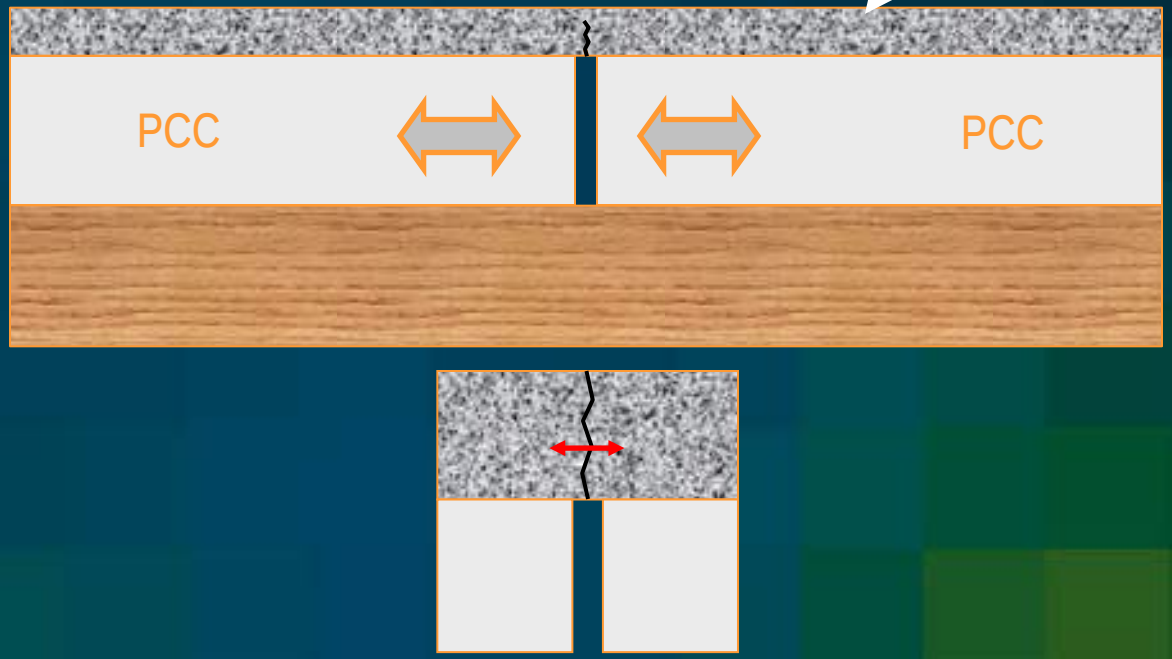

AMPT Flow Number (cycles)
2,500
2,000
1,500
1,000
500
0
590
982
1,079
1,796
NuStar Flexgard (Unaged)
NuStar HiMA (Unaged)
NuStar Flexgard (Aged)
NuStar HiMA (Aged)

Texas Overlay Tester



Texas Overlay Tester

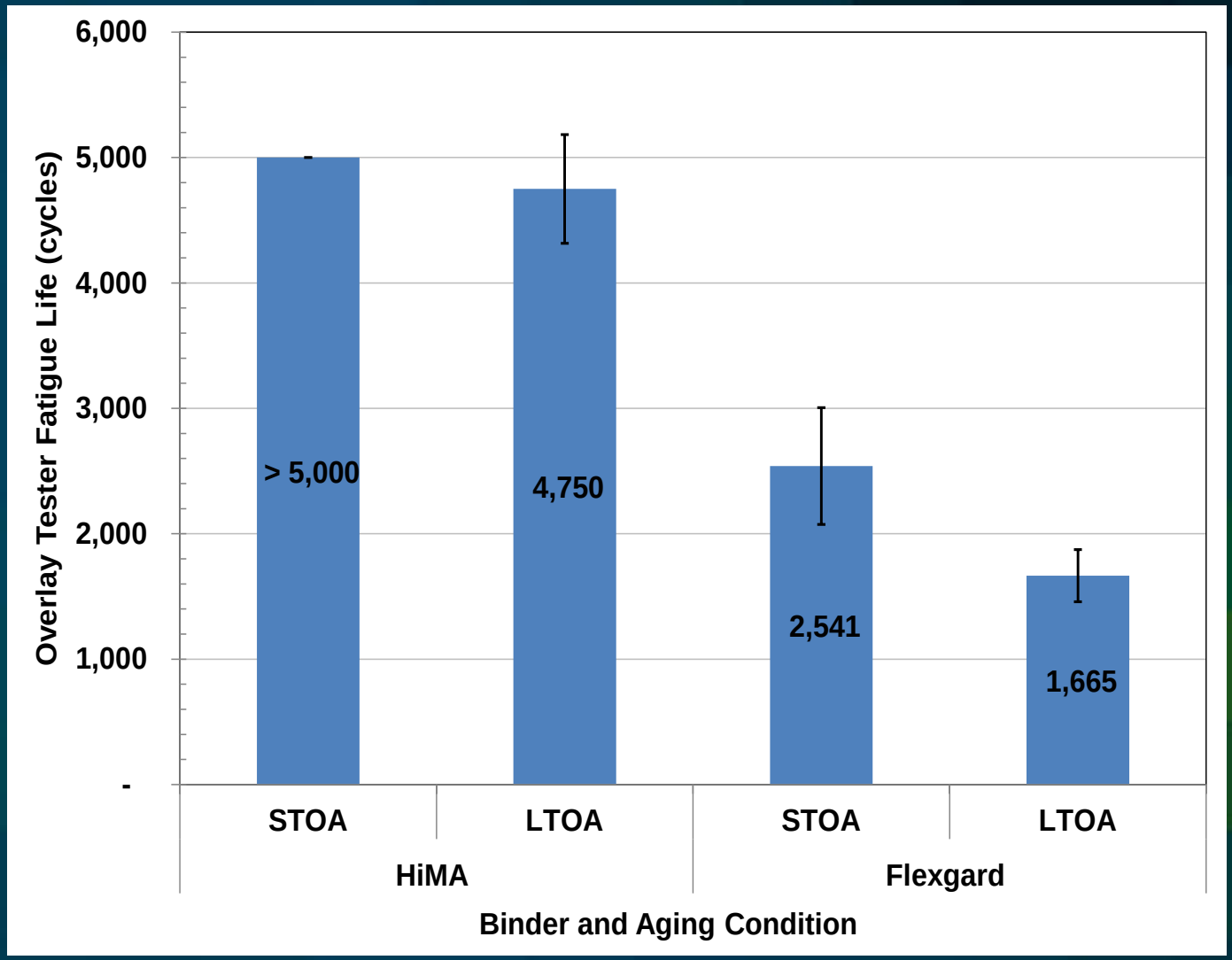
Hot Mix Asphalt Overlaid on PCC



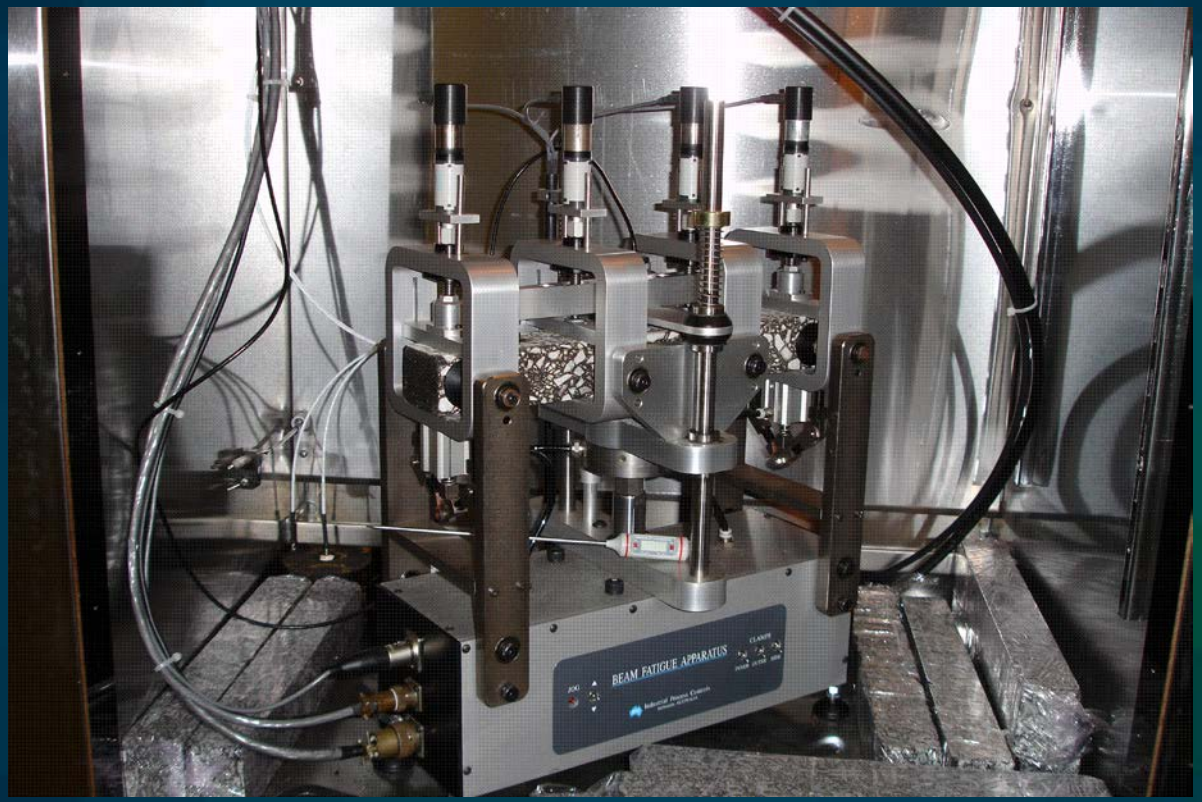
Horizontal Tensile Stress due to Expansion/Contraction of PCC from Temperature

Horizontal Stress/Strain is modeled using Overlay Tester

Texas Overlay Tester

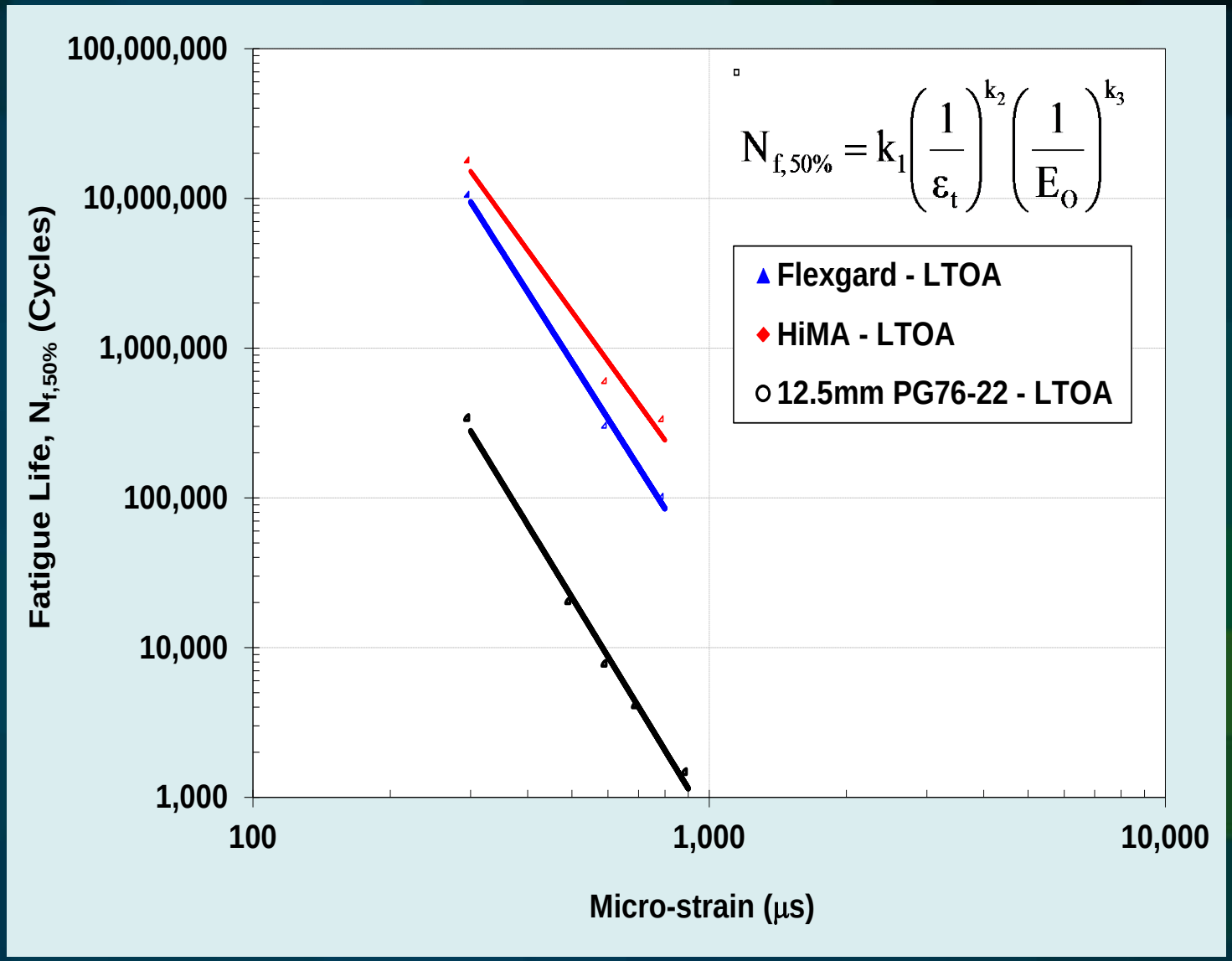


Flexural Beam Fatigue



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

Flexural Beam Fatigue



Tensile Strength Ratio

NuStar NYC Flexgard			
Specimen Type	Indirect Tensile Strength		Average TSR (%)
	Dry	Conditioned	
AASHTO T283 Conditioned	121.2	106.6	***81.7%***
	126.9	102.4	
	130.0	99.8	
	126.0	***102.9***	

NuStar NYC HiMA			
Specimen Type	Indirect Tensile Strength		Average TSR (%)
	Dry	Conditioned	
AASHTO T283 Conditioned	132.2	113.7	***86.4%***
	130.8	112.6	
	127.1	110.7	
	130.0	***112.4***	

HPTO Mix in NYC

- **HPTO mix containing each binder was placed on 1st Avenue on September 25, 2012**
  - **HiMA placed between 100th and 101st Street**
  - **Conventional PMA placed between 101st and 102nd Street**
- **1 1/2” thick overlay in center of street**
- **Tapered thickness to 1” at curb**

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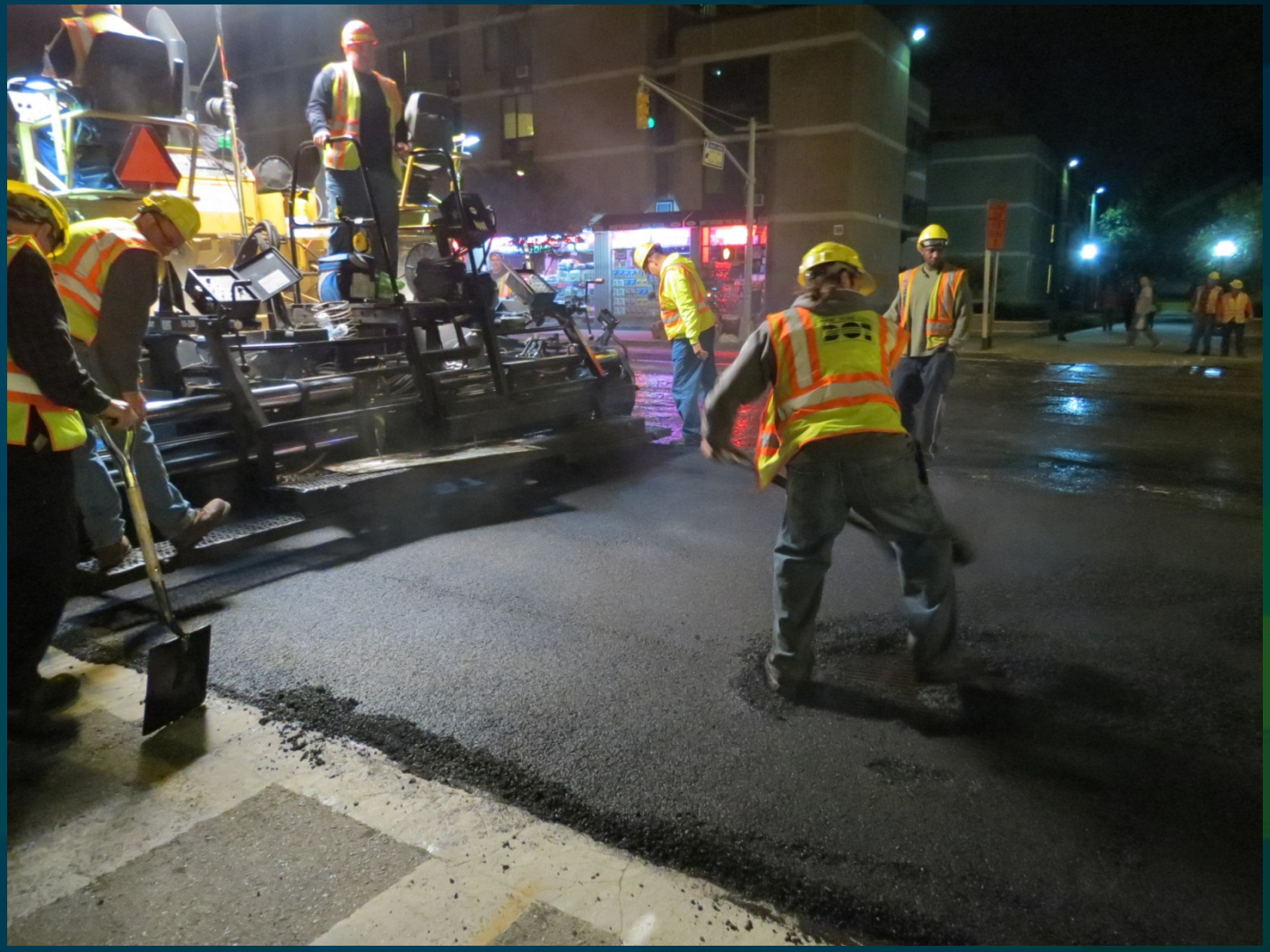

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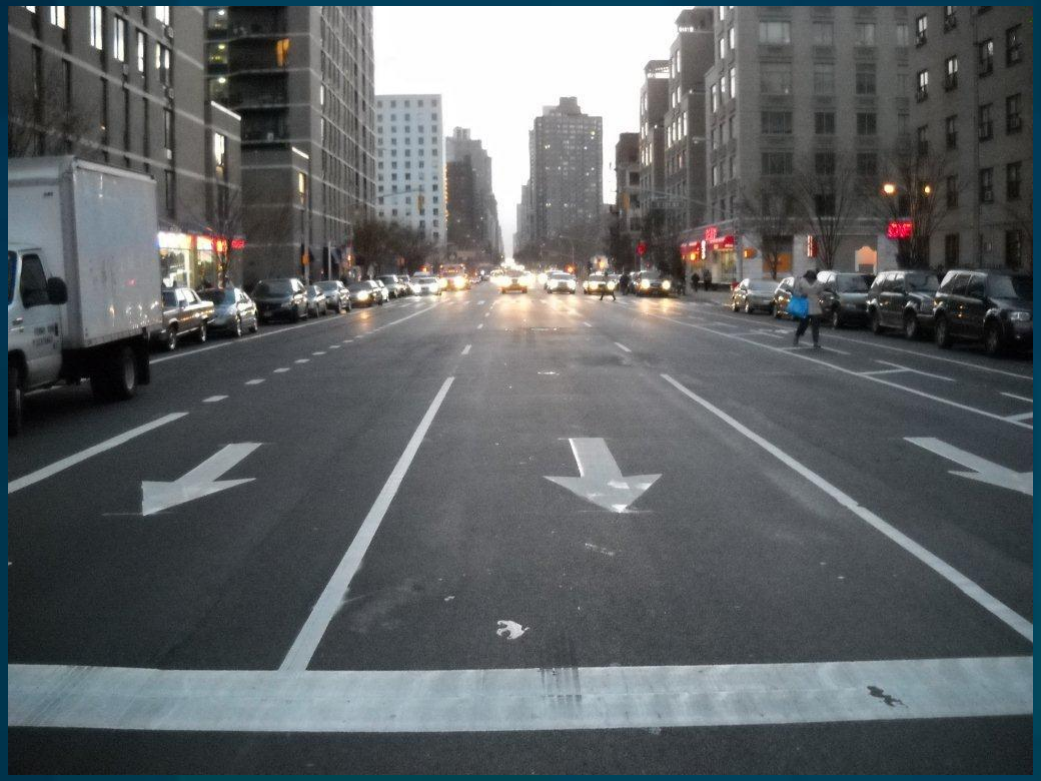

- **NYC DOT will monitor pavement performance and select one of the binders for paving all of 1st Avenue**

Questions?