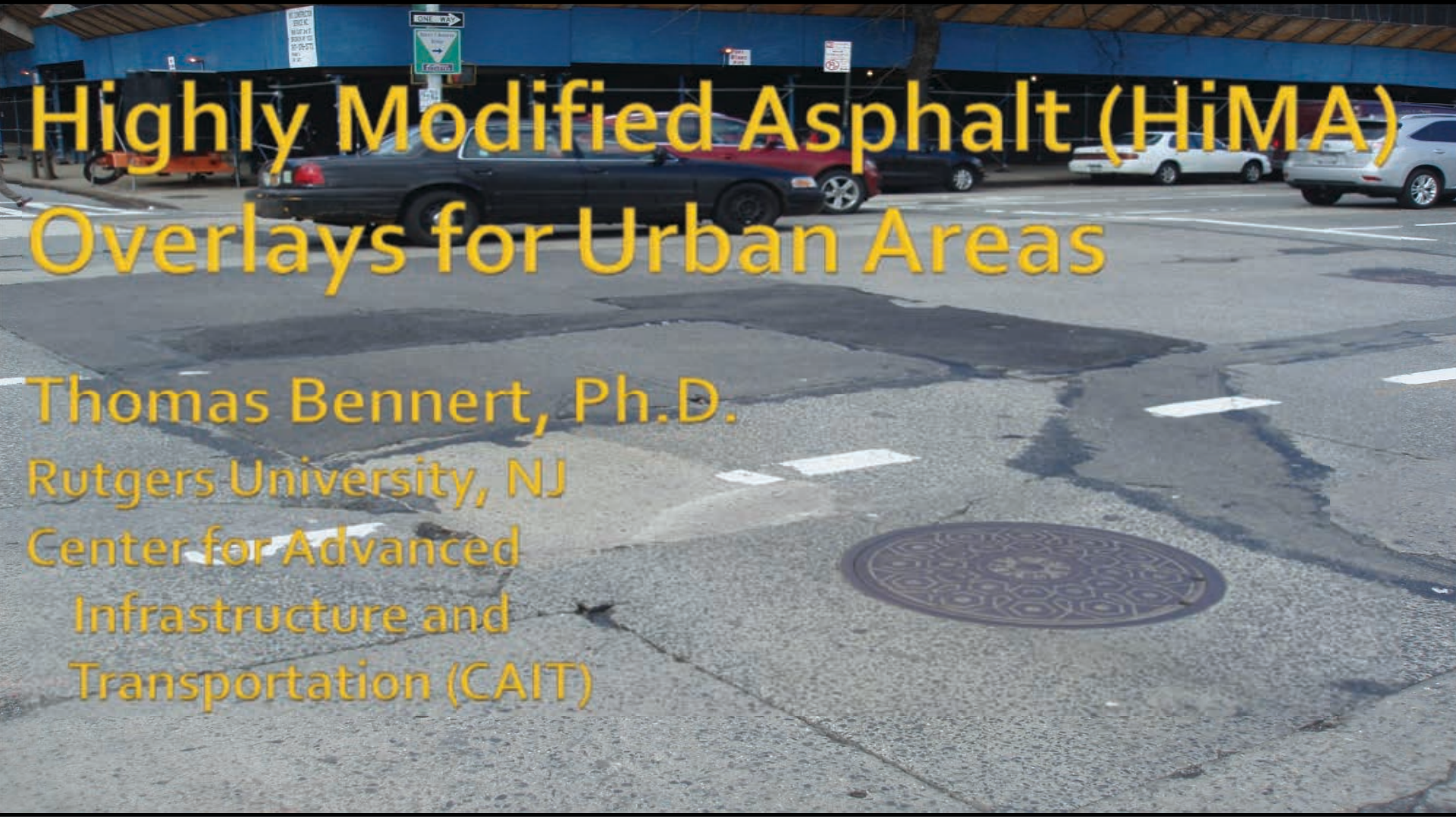

Highly Modified Asphalt (HiMA) Overlays for Urban Areas

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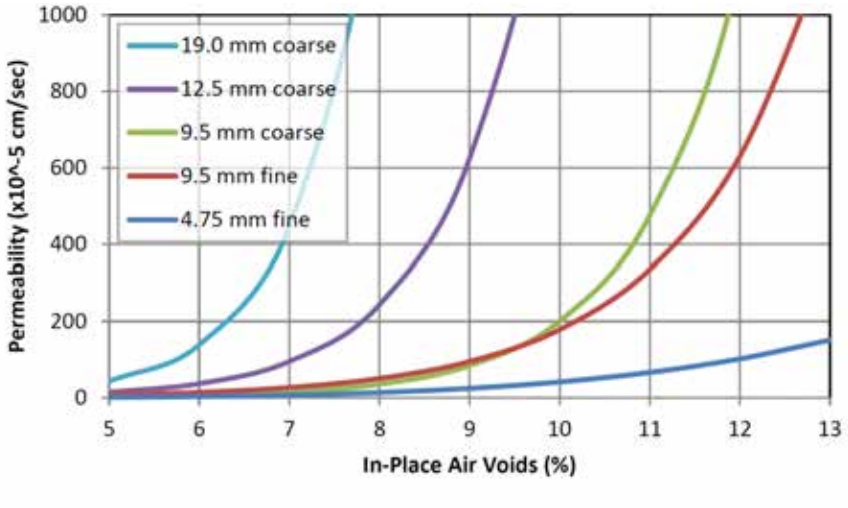
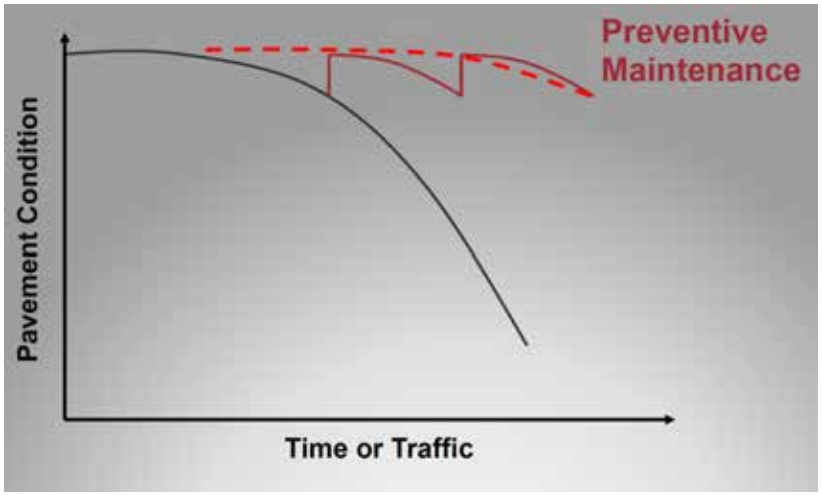
Urban Pavements

- Northeast urban pavements generally contain heavy, slow moving traffic
  - Biggest cost during rehabilitation are utilities and user delays
- Years of multiple overlays, combined with utility work, result in faulted pavement surfaces requiring variability thickness to maintain cross slope and smoothness

Thin Lift HMA Overlays

- Thin lift asphalt overlays provides a means to preserve the pavement while improving the structural and functional properties of the pavement surface
  - Higher AC% for fatigue
  - Finer aggregate and lower in-place air voids for impermeability
  - Faster construction and more flexibility with respect to handwork and leveling





Project Location: 1st Avenue in NYC

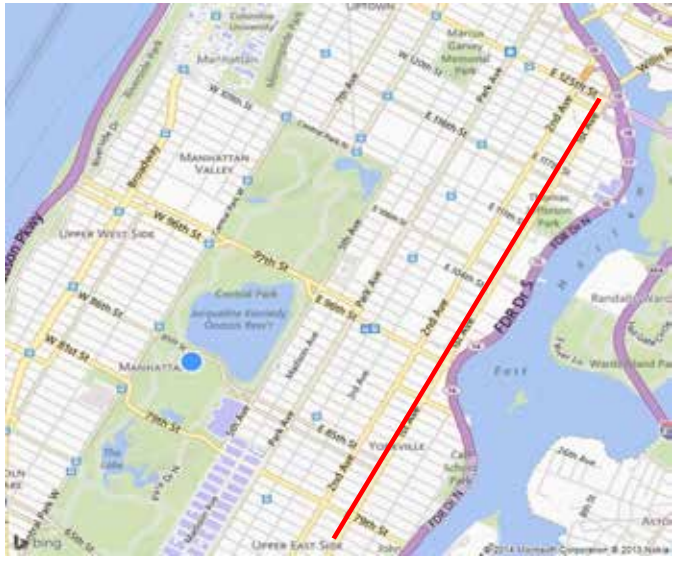
- 1st Avenue in Manhattan is 30 year old 18" thick PCC pavement
- Cost of total replacement far beyond NYC DOT budget for a number of reasons….

1st Avenue in NYC – Underground Utilities

- Utilities beneath the pavement
  - Gas lines
  - Water lines
  - Sewer lines
  - Steam line
- Removing the PCC would most likely damage the utilities
  - NYC DOT tries not to use compaction with vibration when paving streets
  - After paving projects are completed NYC DOT tests utilities for leaks
- Funding not available to replace PCC pavement and the utilities

1st Avenue in NYC – In Addition …

- NYC is planning to improve bus service with an new bus lane on 1st Avenue and also add a bike lane
- Question – How to rehabilitate 1st Avenue?



Rehabilitation Plan

- Rehabilitation Design
  - Micro-mill existing PCC pavement
  - Patch areas as required
  - 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 Sept 2013

1st Avenue Micro-Milling

1st Avenue Micro-Milling

1st Avenue Micro-Milling

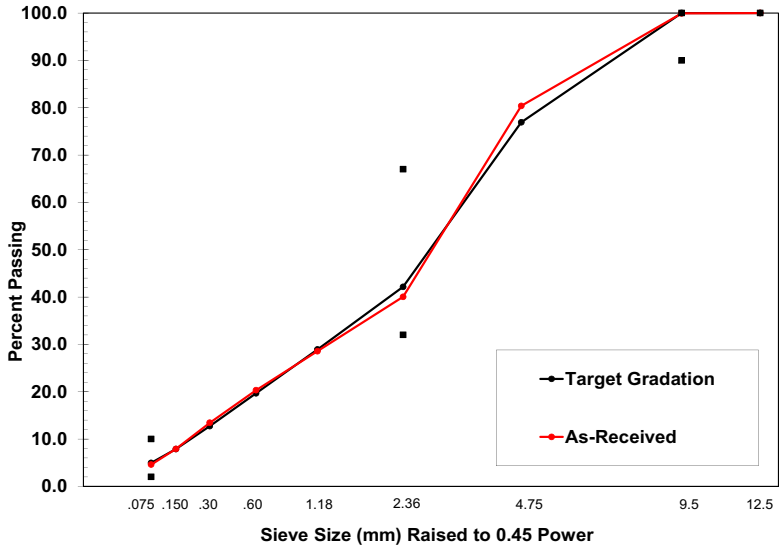
1st Avenue Crack Sealing and Patching

1st Avenue Crack Sealing and Patching

1st Avenue Tack Coat and Fabric

Highly Modified Asphalt (HiMA) Mixture

- Mixture designed after NJDOT's High Performance Thin Overlay (HPTO)
  - N_{des} = 50 gyrations
  - VMA > 18%
  - APA rutting < 4.0 mm
  - Overlay Fatigue > 700 cycles
    - Added for this project to ensure fatigue cracking resistance



Mixture Summary Report for Varying %AC Analysis

Project Name:	NuStar NYC HPTO Mix Design	**N Initial:**	8
Workbook Name:	NuStar NYC HPTO - Blend 20	**N Design:**	50
Technician:	Tom Bennert	**N Max:**	50
Date:	4/24/12	**Nom. Sieve Size:**	9.5 mm
Asphalt Grade:	FlexGard	**Compaction Temperature:**	144 °C
		Mixture Temperature:	152°C
Design ESAL's (millions):	20.	**Depth from Surface (mm):**	0 mm
Design Temperature:	36°C	**Mold Size:**	150 mm

Property	Results 6.5% AC	7.0% AC	7.2% AC	7.5% AC	Criteria
%AC	6.5	7.0	7.2	7.5	
%Air Voids (V_a)	7.4	4.0	3.6	2.9	3.5 %
%VMA	21.6	19.6	19.7	19.8	18.0 % Min.
%VFA	65.7	79.5	81.7	85.6	73.0 % Min.
					76.0 % Max.
Dust/Asphalt Ratio	0.8	0.7	0.7	0.7	0.6 - 1.2 %
Max. Specific Gravity (G_{mm})	2.436	2.423	2.416	2.400	
Bulk Specific Gravity (G_{mb})	2.256	2.325	2.329	2.331	
$\%G_{mm}$ @ N_{ini}	85.5	86.3	86.5	87.0	89.0 % Max.
$\%G_{mm}$ @ N_{des}	92.6	96.0	96.4	97.1	96.5 % Max.
Effective Sp. Gravity of Blend (G_{se})	2.692	2.699	2.699	2.691	---
Sp. Gravity of Binder (G_b)	1.028	1.028	1.028	1.028	---
Sp. Gravity of Aggregate (Gs_b)	2.690	2.690	2.690	2.690	---
			OPTIMUM		

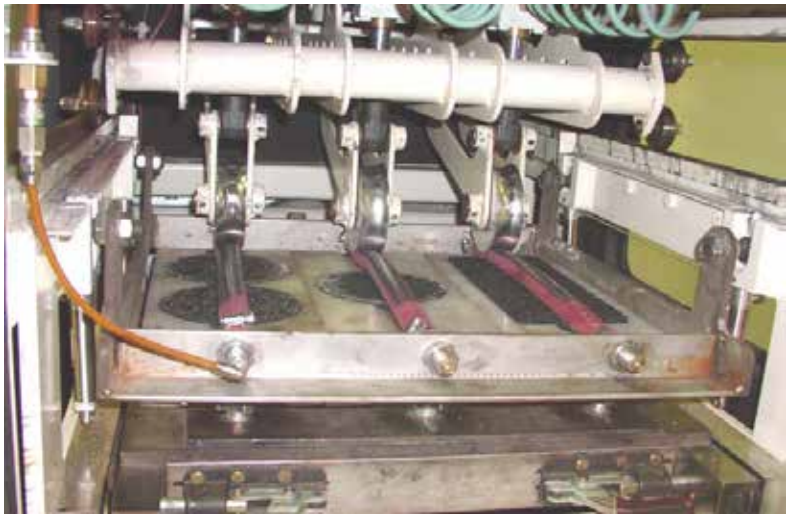
HiMA vs Typical NYC HMA

- HiMA sampled during production and compared to NYC Surface Course mixture
  - NYC mix sampled from same asphalt plant prior to 1st Avenue project

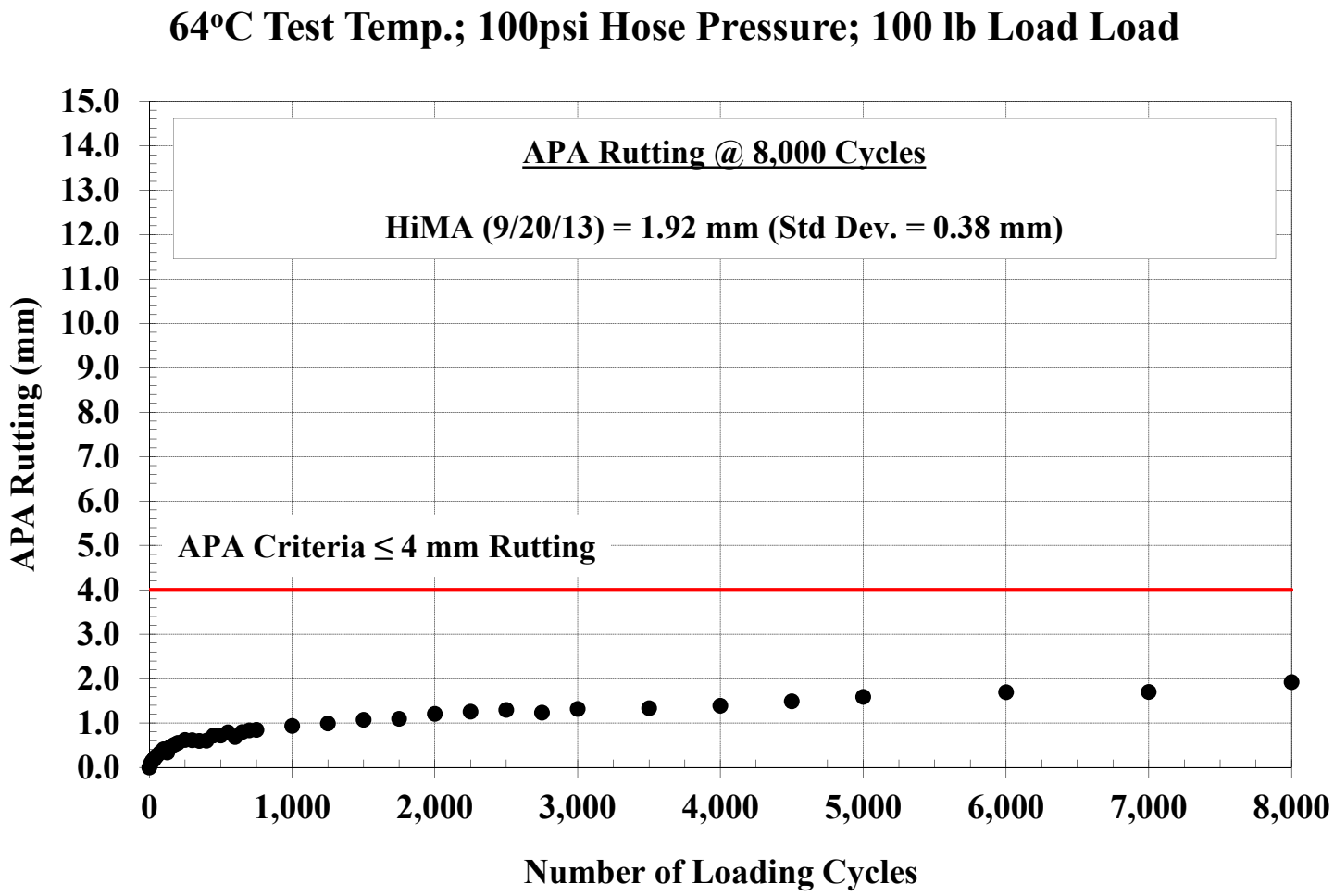
NYC Surface Course Mixture vs HiMA			
Sieve Number	**Opening Size (mm)**	**NYC Surface Mix**	**Highly Modified Asphalt (HiMA)**
2.0"	50.00	100.0	100.0
1.5"	37.50	100.0	100.0
1.0"	25.00	100.0	100.0
3/4"	19.00	100.0	100.0
1/2"	12.50	98.4	100.0
3/8"	9.50	92.4	99.4
1/4"	6.39	73.4	
# 4	4.75	59.5	69.5
1/8"	3.15	43.8	
# 8	2.36	36.8	38.7
# 16	1.18	26.7	26.9
# 30	0.60	20.8	19.5
# 50	0.30	15.2	13.2
# 100	0.15	9.7	7.0
# 200	0.075	6.5	3.6
PG Grade Information (After Extraction and Rotavap Recovery)			
Continuous PG Grade	PG73.9-26.1 (21.3)		86.6-31.9 (14.4)
Asphalt Content (%)	4.83%		6.53%

Asphalt Pavement Analyzer

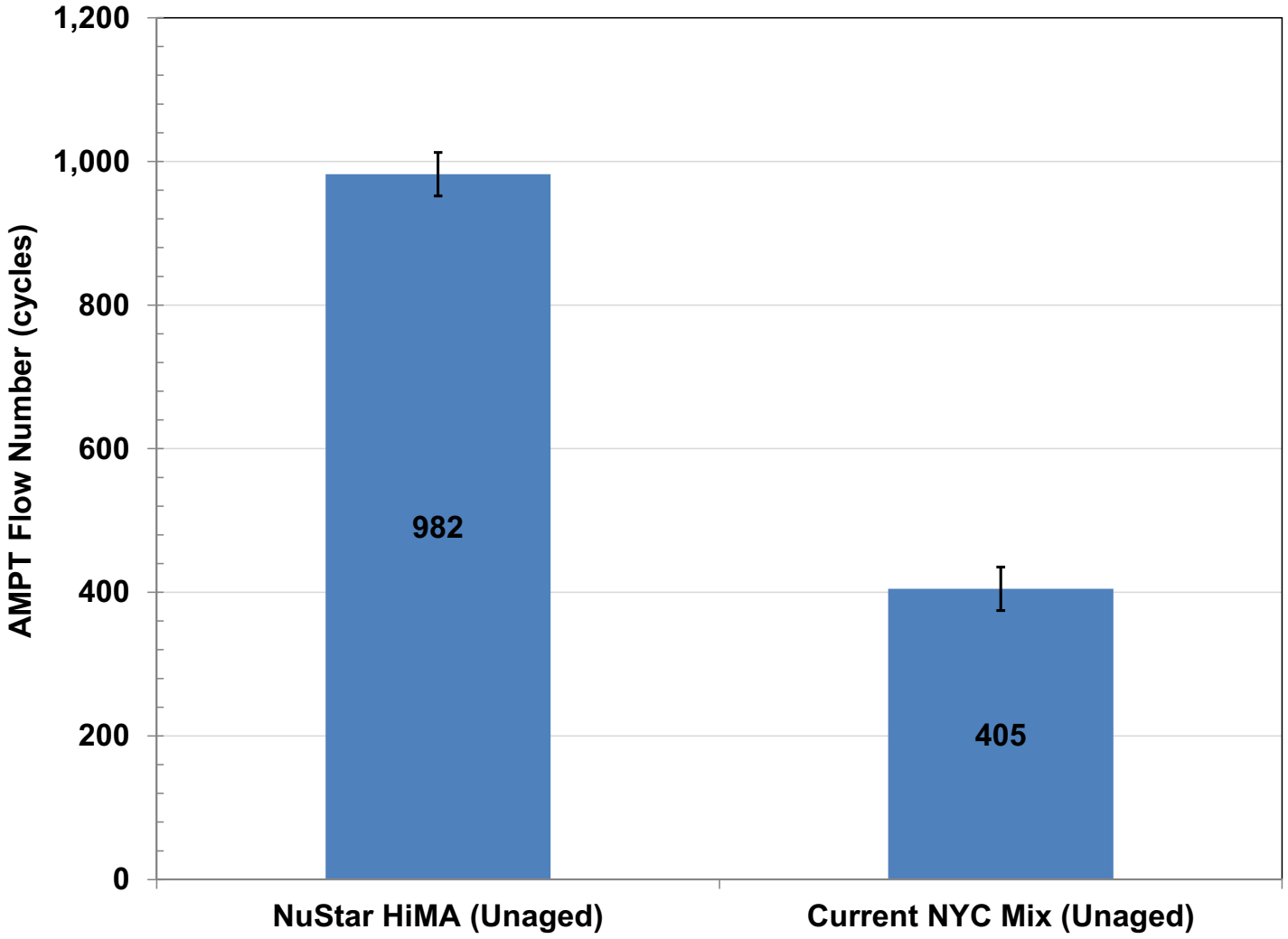
- AASHTO T340
- 100 lb. wheel load; 100 psi hose pressure
- Tested at 64°C (148°F) for 8,000 cycles
- Samples at specified air voids
- APA Rutting < 4.0 mm to pass



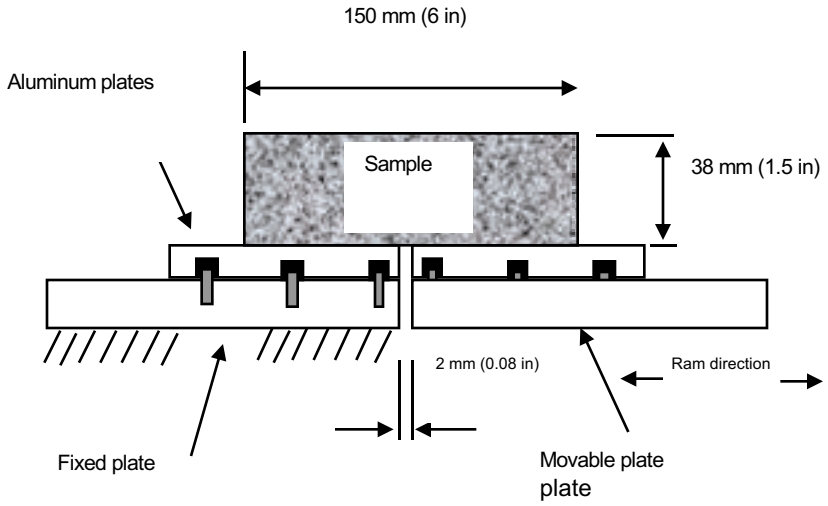
APA Rutting Results



AMPT Flow Number @ 54°C

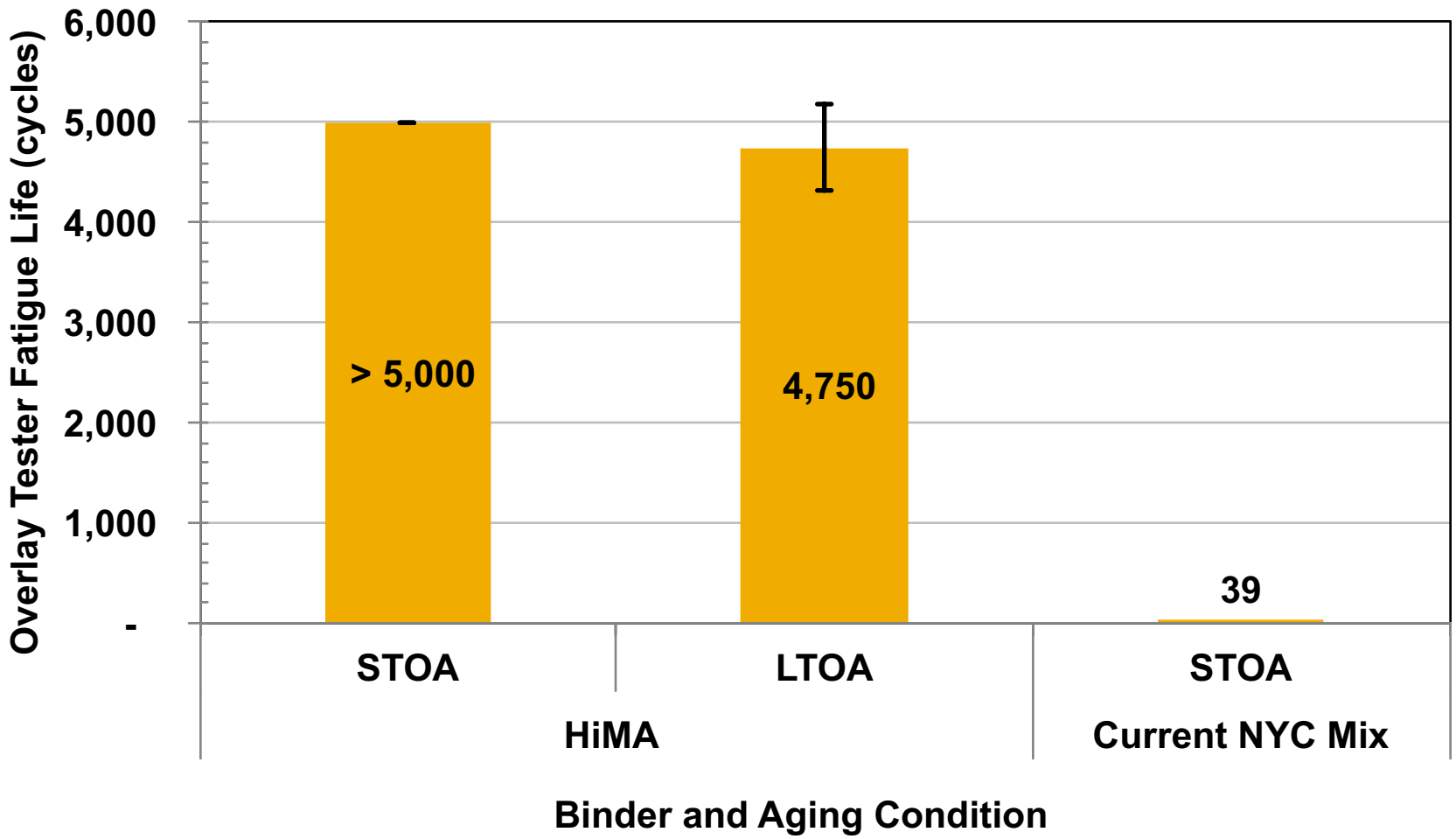


Overlay Tester



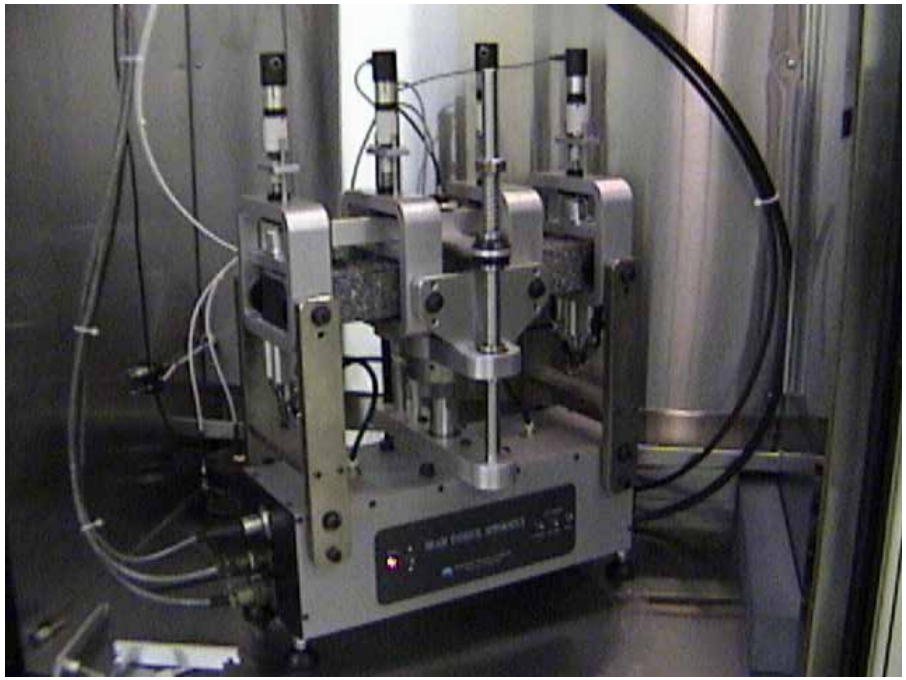
- Sample size: 6" long by 3" wide by 1.5" high
- Loading: Continuously triangular displacement 5 sec loading and 5 sec unloading
- Definition of failure
  - Discontinuity in Load vs Displacement curve

Overlay Tester Results

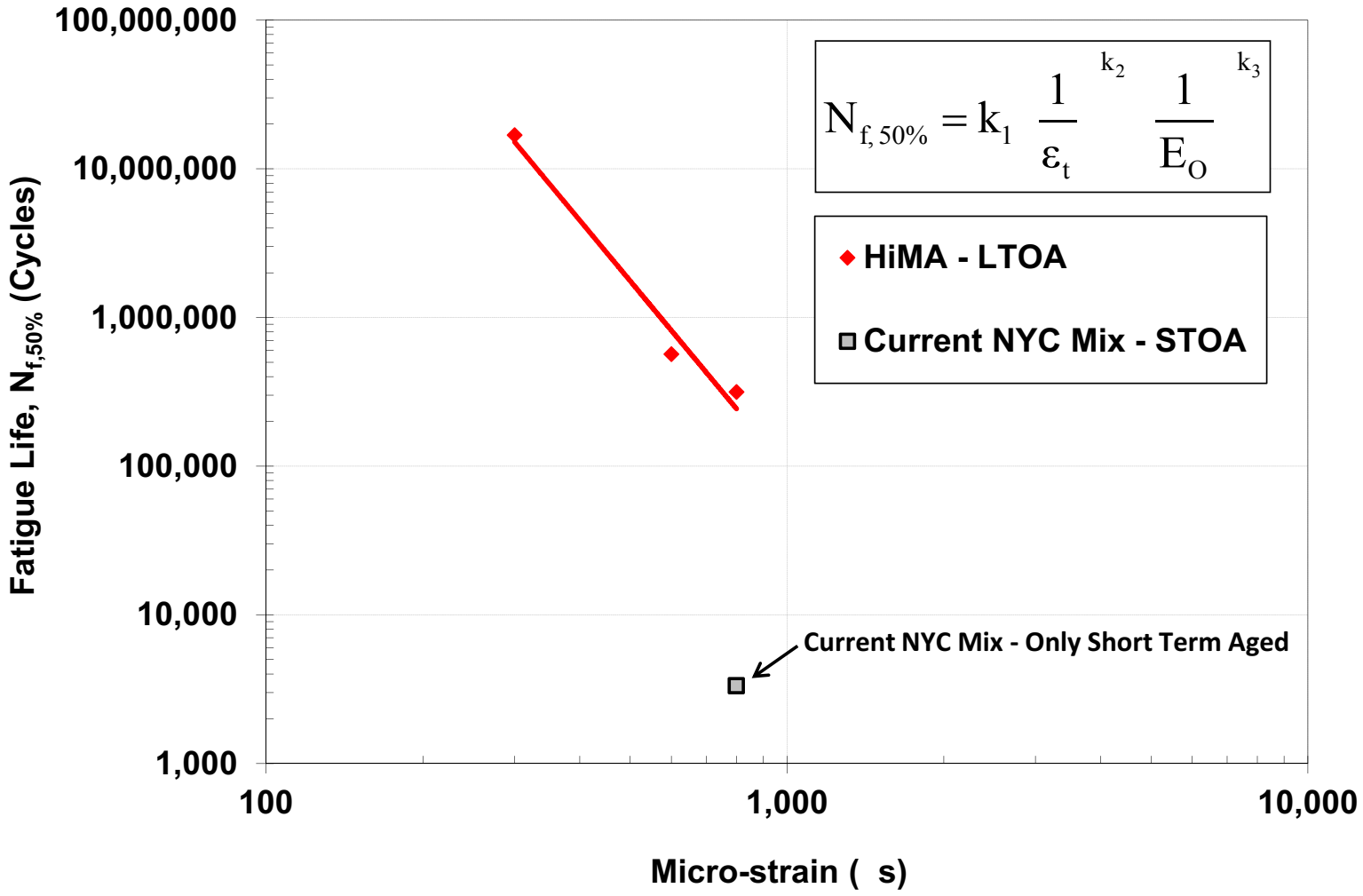


Flexural Beam Fatigue

- Flexural Beam Device, AASHTO T321
- Test mixes ability to withstand repeated bending
- Run at strain controlled mode to simulate bending/deformation in the field



Flexural Beam Fatigue Results



1st Avenue Paving on Fabric

1st Avenue Paving – September 2013

1st Avenue Paving – September 2013

1st Avenue Finished HiMA Pavement – September 2013

1st Avenue – November 2014

1st Avenue – November 2014

1st Avenue – June 2015

Conclusions

- Urban pavement systems provide a significant challenge to rehabilitate due to the multiple construction constraints
- Thin lift asphalt mixtures provide a structural and functional asphalt overlay system to help preserve the underlying pavement structure
- For NYC 1st Avenue, a highly modified asphalt (HiMA) was utilized to minimize rutting and fatigue cracking potential
  - WMA additive was used to help achieve low air voids without using vibratory mode on compactor
- 2 years after construction, pavement looks in great conditions – with no utility cuts yet!!!

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