Testing a Thinner, Highly Modified Perpetual Pavement on the Ohio University APLF

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Implementation and Thickness Optimization of Perpetual Pavements in Ohio

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OHIO UNIVERSITY

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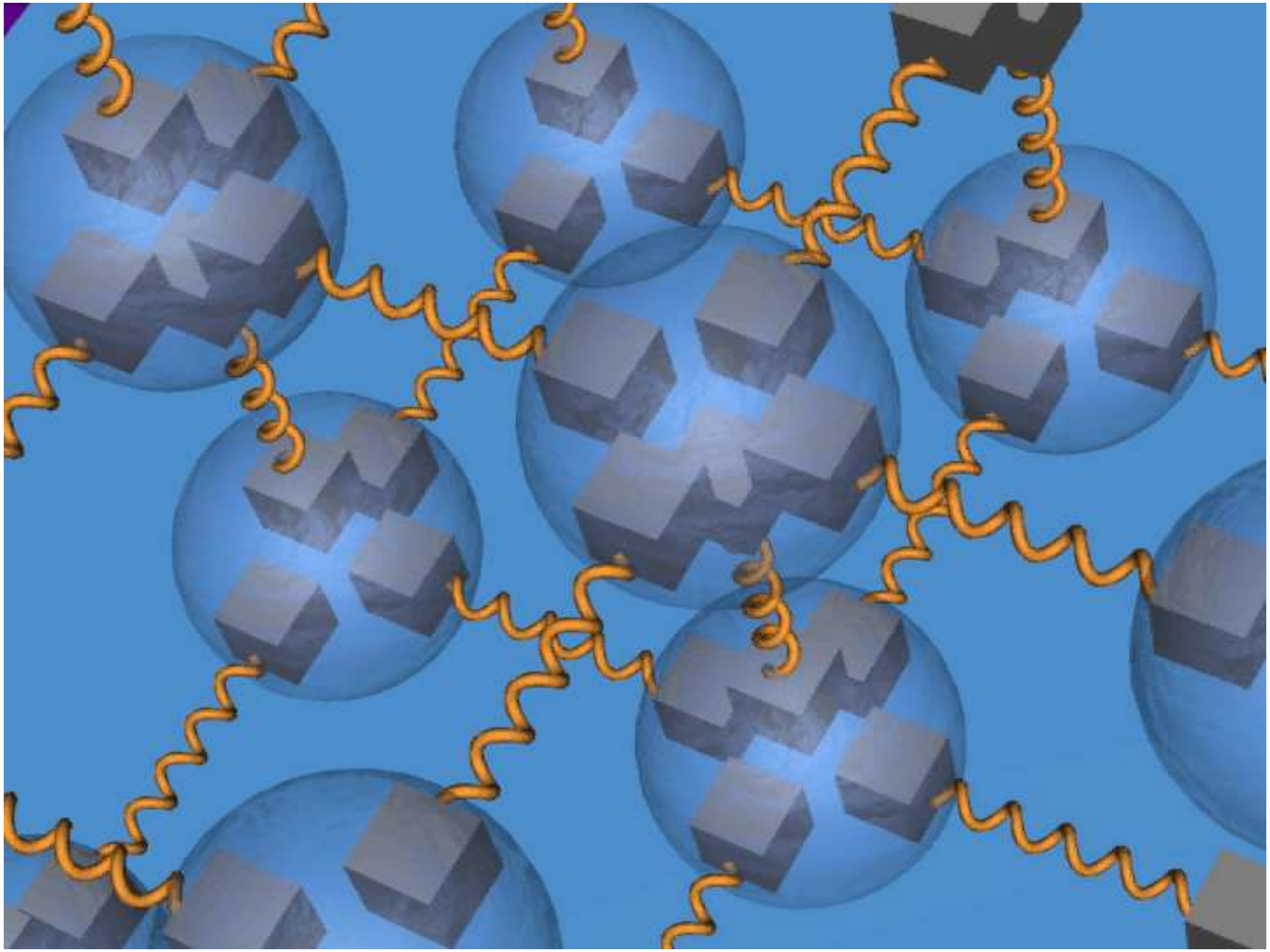
Excerpt from larger Ohio University perpetual pavement study

Report No. FHWA/OH-2025/17

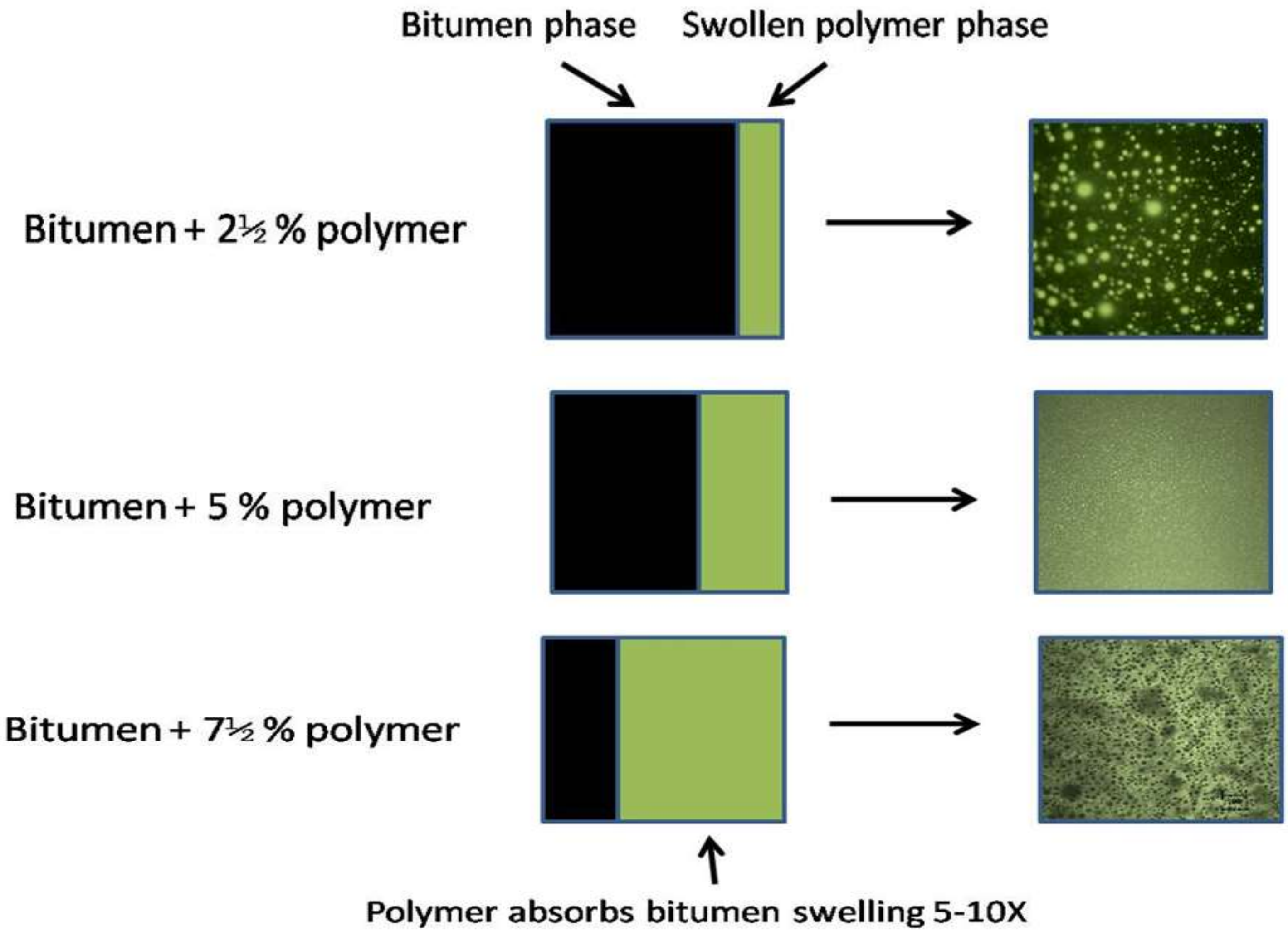
Outline

- What is HiMA?
- Ohio University Accelerated Pavement Loading Facility (APLF)
- Pavement Sections Constructed
- Testing
- Performance
- Conclusions

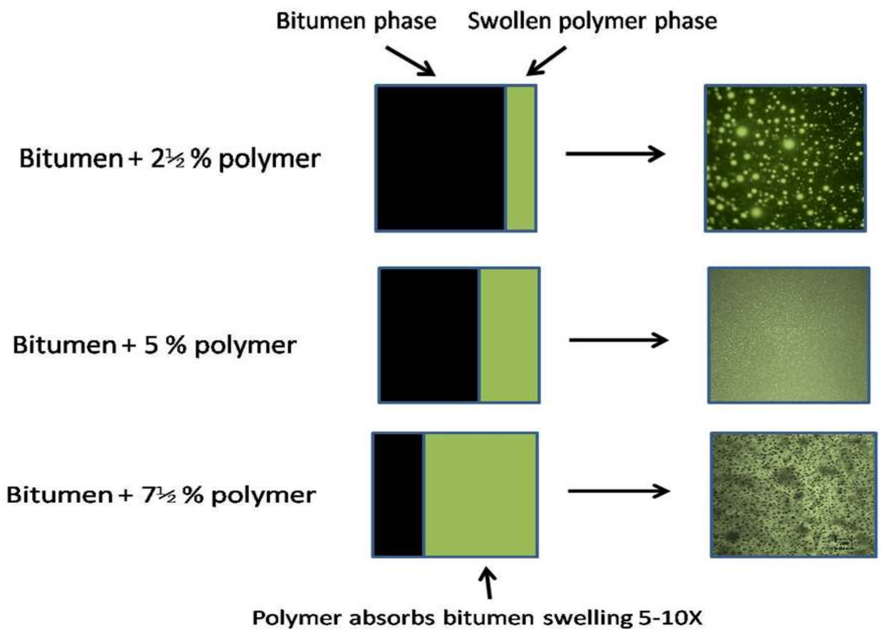
SBS in Bitumen



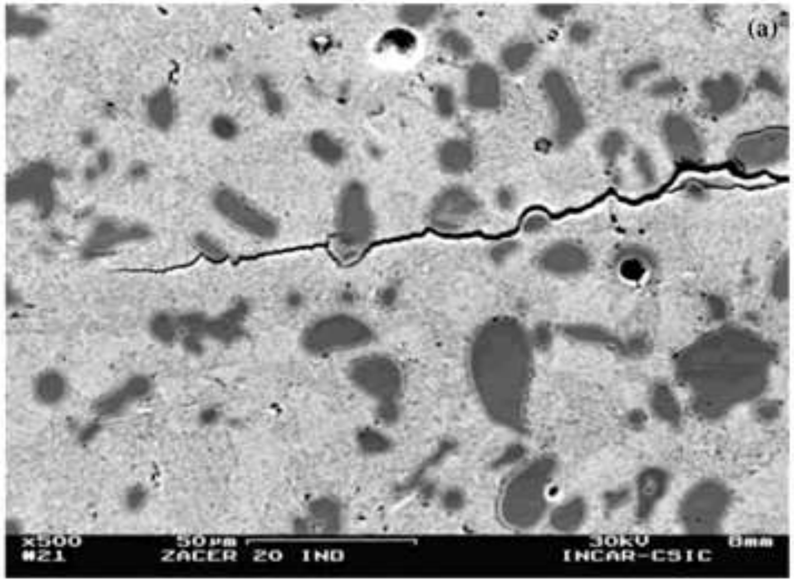
Phase Morphology



What Is Highly Modified Asphalt?



- Highly Modified Asphalt is exactly what it says, asphalt with more than double the normal amount of SBS polymer.
- This gives a much denser polymer network with up to 10X rutting **and** fatigue cracking resistance.



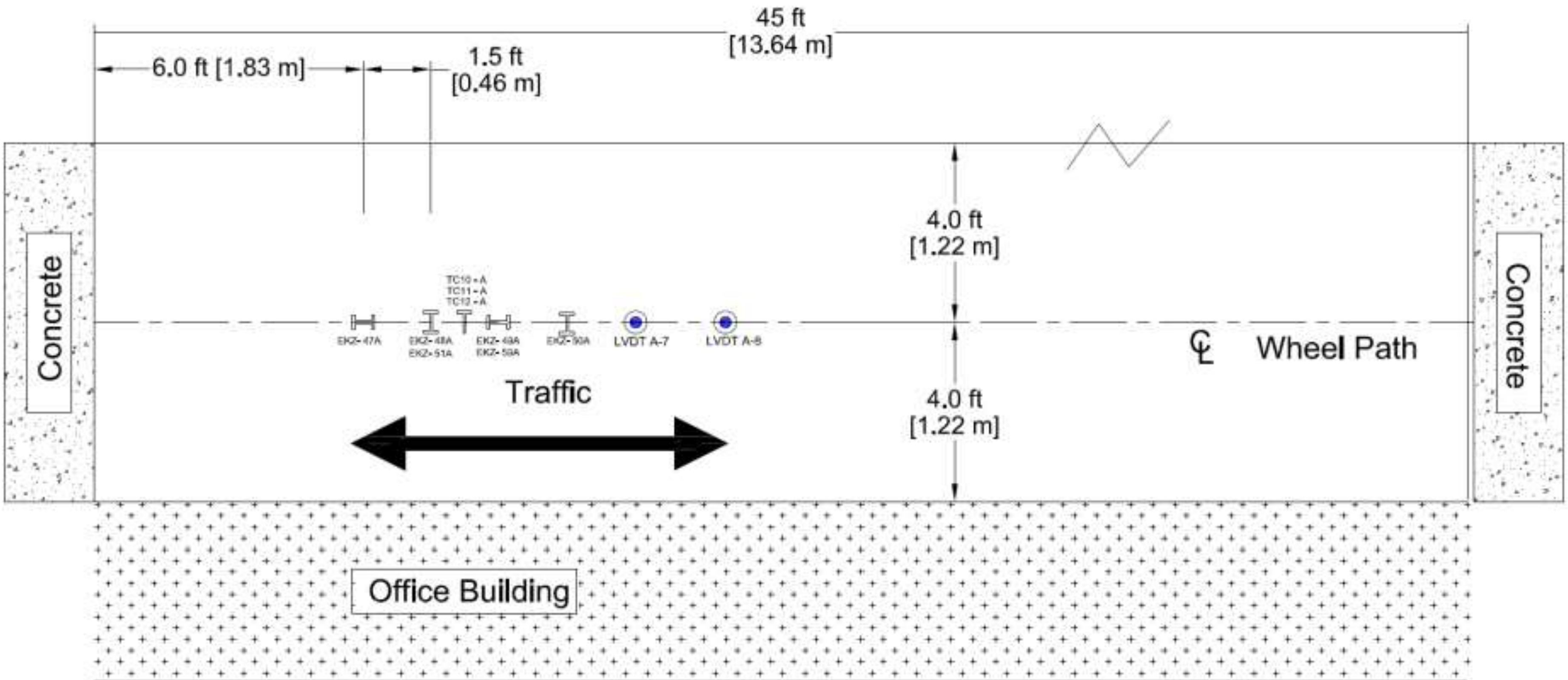
Over 3,000,000 tons around the world.

Demonstrated **superior performance** at **reduced thickness**.

Accelerated Pavement Loading Facility (APLF)

- The APLF is an indoor pavement testing facility at Ohio University Lancaster.
- It comprises four lanes with tire loading capability up to 5 mph and up to 30 kip.
- Instrumentation per lane includes two longitudinal and two transverse strain gauges 18 inches apart at the bottom of the asphalt layer and a pressure cell at the top of the subgrade with deep and shallow subgrade LVDTs.
- Three thermocouples per lane.
- The entire pavement is heated and typical tests are conducted at 40, 70 and 104 °F at loadings of 6, 9 and 12 kip.
- It has been used for perpetual pavement design thickness studies using standard Ohio materials at thicknesses of 13 to 16 inches.

APLF Layout



Gauge layout in APLF test lane A.
Other three lanes are similar.

Image from Report No. FHWA/OH-2015/17

APLF Loading Wheel

Loaded wheel passing over test pavement

Image from Report No. FHWA/OH-2015/17

APLF – ORITE Profilometer Measurement

ORITE rolling wheel profiler

Image from Report No. FHWA/OH-2015/17

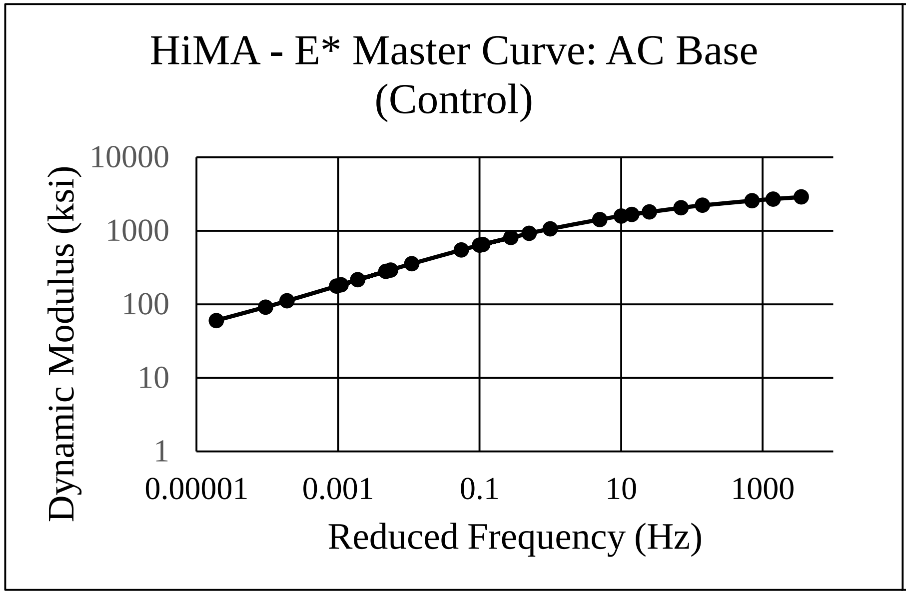
APLF Test Section Layer Thicknesses

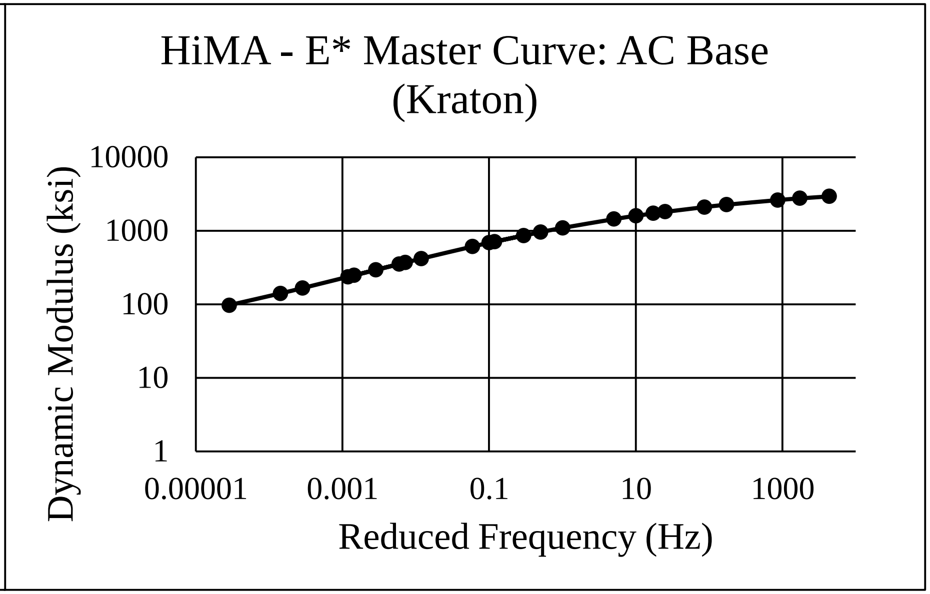
Layer	ODOT Item	Layer thickness for each section			
		Lane A (HiMA) (in)	Lane B (HiMA) (in)	Lane C (HiMA) (in)	Lane D (Control) (in)
Surface	424	1.50	1.50	1.50	1.50
Intermediate	442	1.75	1.75	1.75	1.75
AC Base	302	4.75	5.75	6.75	7.75
Total AC	-	**8.00**	**9.00**	**10.00**	**11.00**
Aggregate Base	304	6.00	6.00	6.00	6.00
Cement stabilized subgrade	206	18.00	18.00	18.00	18.00
Subgrade (type)	-	A-6/A-7	A-6/A-7	A-6/A-7	A-6/A-7

APLF Test Section Mix Design & Volumetrics

Layer	Surface	Intermediate	AC Base-HiMA	AC Base-Ctrl
Mix (ODOT No.)	424	442	302	302
Gradation (%)				
2" (50.8 mm)	100	100	100	100
1 1/2" (38 mm)	100	100	100	100
1" (25.4 mm)	100	100	87	87
3/4" (19 mm)	100	96	78	78
1/2" (12.5 mm)	100	80	68	68
3/8" (9.5 mm)	93	69	58	58
#4 (4.75 mm)	57	48	39	39
#8 (2.36 mm)	38	35	28	28
#16 (1.18 mm)	27	26	22	22
#30 (0.600 mm)	19	18	16	16
#50 (0.300 mm)	11	11	9	9
#100 (0.150 mm)	7	7	6	6
#200 (0.075 mm)	4.8	4.9	4.3	4.3
Agg. Blend G_{sb}	2.393	2.636	2.646	2.646
G_{mm}	2.440	2.496	2.480	2.485
% Binder Content	5.7	4.4	4.4	4.3
% Virgin Binder	5	3.2	2.7	2.5
Asphalt Binder	PG 88-22M	PG 88-22M	PG 88-22M	PG 64-22
Design, Air Voids (%)	3.5	4	4	4
F/A	0.8	1.1	-	-
RAP %	15	25	35	35

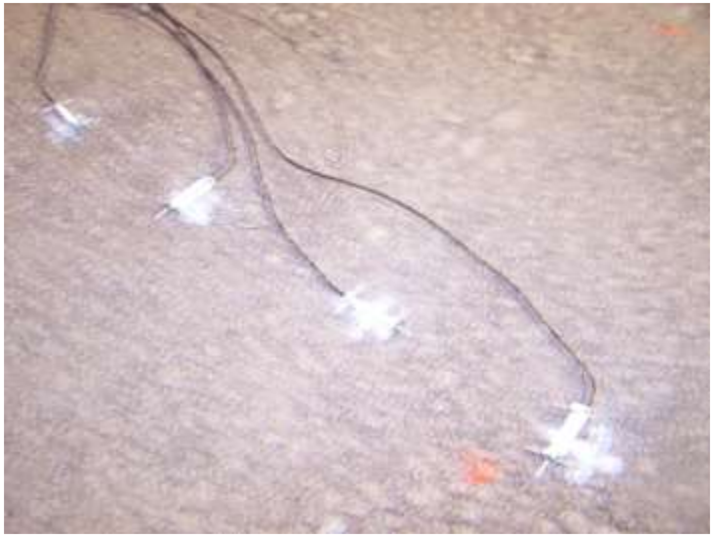
Comparative Mixture Modulus





Same modulus at high frequency, low temperature
Higher modulus a low frequency, high temperature

HiMA APLF Construction Dec 5-6, 2013 (COLD!)




HiMA APLF Construction Dec 5-6, 2013 (COLD!)

HiMA APLF Testing

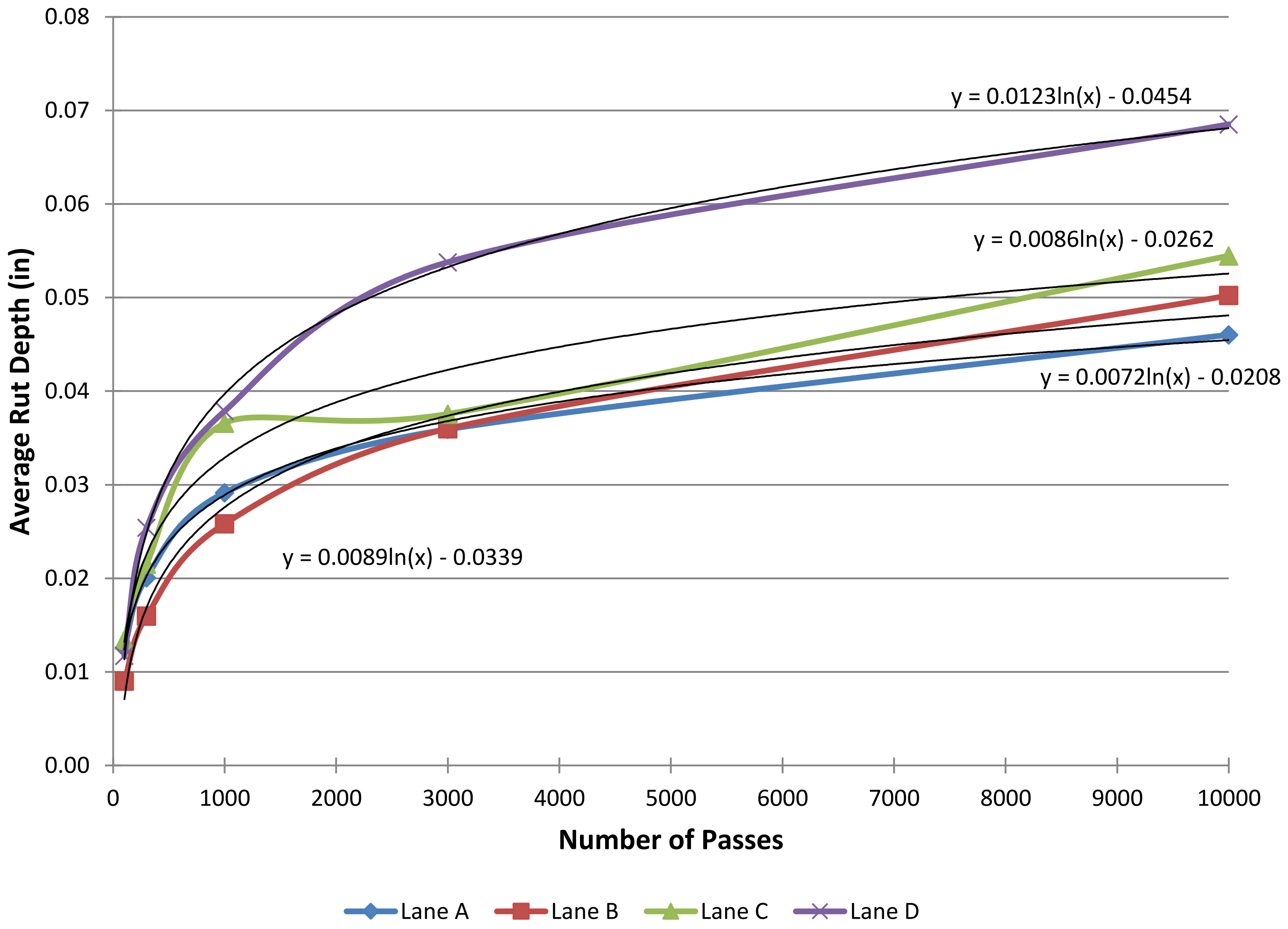
- Dynamic load testing May through September 2014. Upon completion of 10,000 passes on all lanes at 70 °F, the temperature was increased to 100 °F and allowed to stabilize through the pavement thickness and 10,000 passes were then applied to all lanes at the higher temperature.
- Profiles were taken to measure rutting of each test section prior to loading and upon completion of 100, 300, 1000, 3000, and 10,000 passes of a 9000 lb load.
- After completion of 100, 3000, and 10,000 passes, the lead wires were attached to the LVDTs and twelve passes each at 6000, 9000 and 12,000 lb, at various offsets to the centerline of the lane, were applied to analyze the test section's pavement response.
- The tire speed was approximately 5 mph.
- Longitudinal strains in the base layer of each test section were compared to calculated endurance limits to determine which sections met the perpetual pavement design criteria.
- Deflections were measured at the bottom of the 304 aggregate base and 36in into the subgrade.
- No cracking was observed on any section

Longitudinal Strains in Base Layer (µε)

Lane	AC thickness		Load (lb)					
			6000		9000		12,000	
	(in)	(cm)	Avg	Max	Avg	Max	Avg	Max
70° F								
A	8	20	35	43	54	61	70	79
B	9	23	31	36	48	54	62	69
C	10	25	21	24	35	39	46	51
D	11	28	27	43	40	55	52	67
100° F								
A	8	20	62	66	89	93	106	113
B	9	23	41	46	63	73	79	83
C	10	25	34	44	50	56	61	67
D	11	28	27	34	43	56	56	73

Note that strains in the 11 inch control are higher than in the 10 inch highly modified

Rut Depth Development at 100 °F



Rut depth vs. number of passes for HiMA at 100˚F

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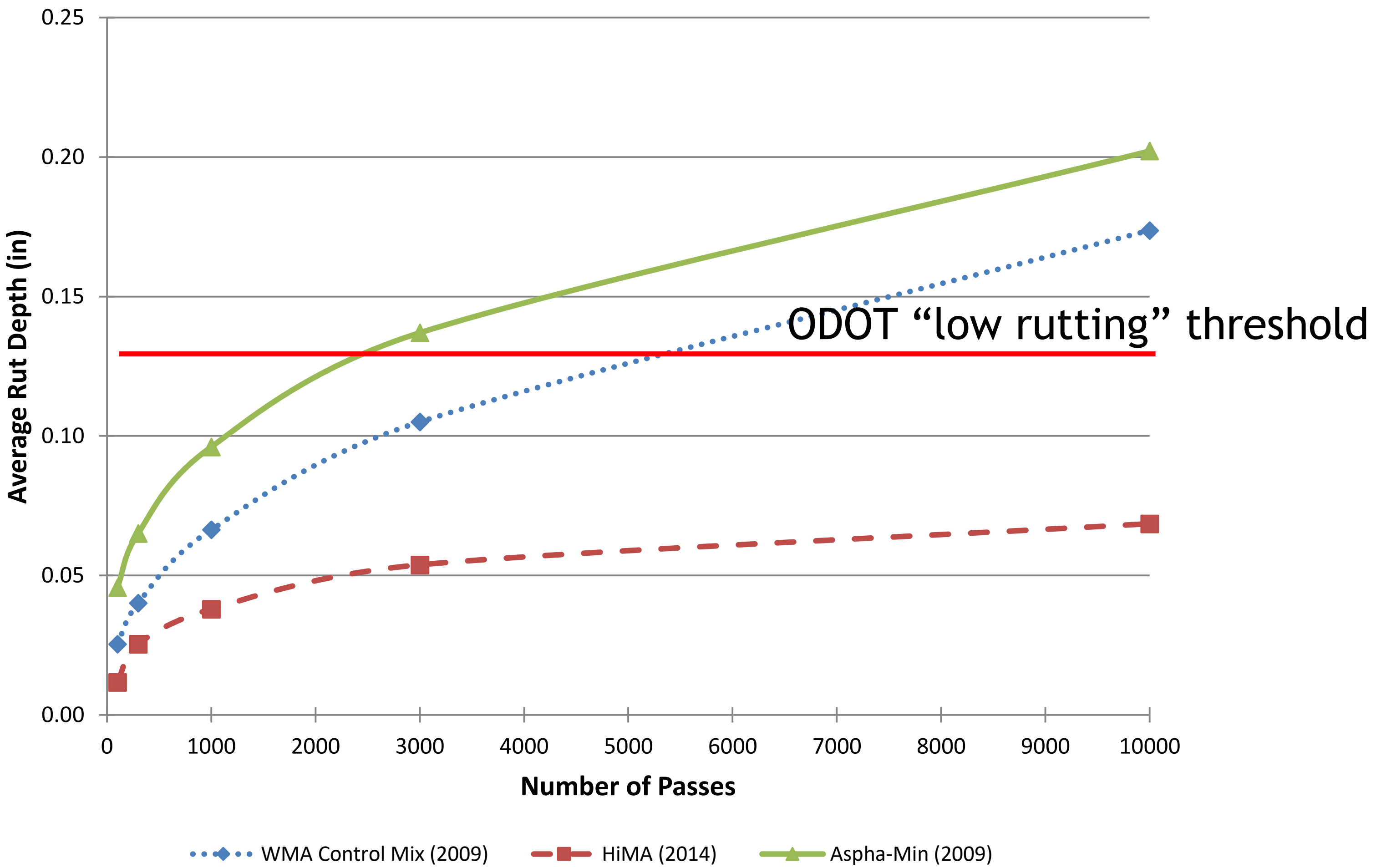
Comparative Rutting*



Comparison of average rut depths between HiMA and WMA mixes at high temperature in APLF

*Sargand, S., Figueroa, J. L., Edwards, W., & Al-Rawashdeh, A. S. (2009). *Performance assessment of warm mix asphalt (WMA) pavements*. (Report No. FHWA/OH-2009/08). Athens, OH: Ohio Research Institute for Transportation and the Environment, Ohio Department of Transportation.

Conclusions*

- Test lanes were constructed in the Accelerated Pavement Load Facility (APLF) which further evaluated thicknesses and included the use of high-polymer content binder, or highly modified asphalt (HiMA). On the built-up sections in the indoor facility, subgrade was stabilized, moisture increase in the subgrade soil typically experienced in the field did not occur, and construction quality was very high.
- In the APLF, based on data collected, all sections satisfied NCHRP Project 9-44A criteria for perpetual pavement**. The 8 in (20 cm) thick well-constructed HiMA pavement on 304 and stabilized subgrade met perpetual pavement criteria in the highly controlled environment of the APLF.
- Very little rutting was observed in the test pavements. Comparing HiMA with control sections there was significant improvement in rutting resistance using the high polymer asphalt.

*Citation from Report No. FHWA/OH-2015/17

**Witczak, M., Mamlouk, M, Souliman, M., and Zeiada, W., 2013, *Laboratory Validation of an Endurance Limit for Asphalt Pavements*. NCHRP Report 762. Transportation Research Board. Washington, D.C.

Conclusions*

- The APLF observations corroborate other performance studies at the National Center for Asphalt Technology (NCAT) as well as commercial projects in Ohio and other states.
- Highly modified asphalt can allow significant thickness reduction in structural pavements while retaining or even improving long term performance.
- With material property global recalibration (as opposed to local calibration), AASHTOWare® Pavement ME Design can be successfully used to predict performance and design pavements with HiMA.

*Kraton Polymers position

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