Global Warm Mix Asphalt Workshop
Coralville, Iowa, October 30-31, 2013

Temperatures and Field Densities of LEADCAP Warm Mix Asphalt

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Acknowledgements: Clint Van Winkle, Russ Carlson, Hanjun Kim and Jeremy Nash, Mattehw Gazdziak

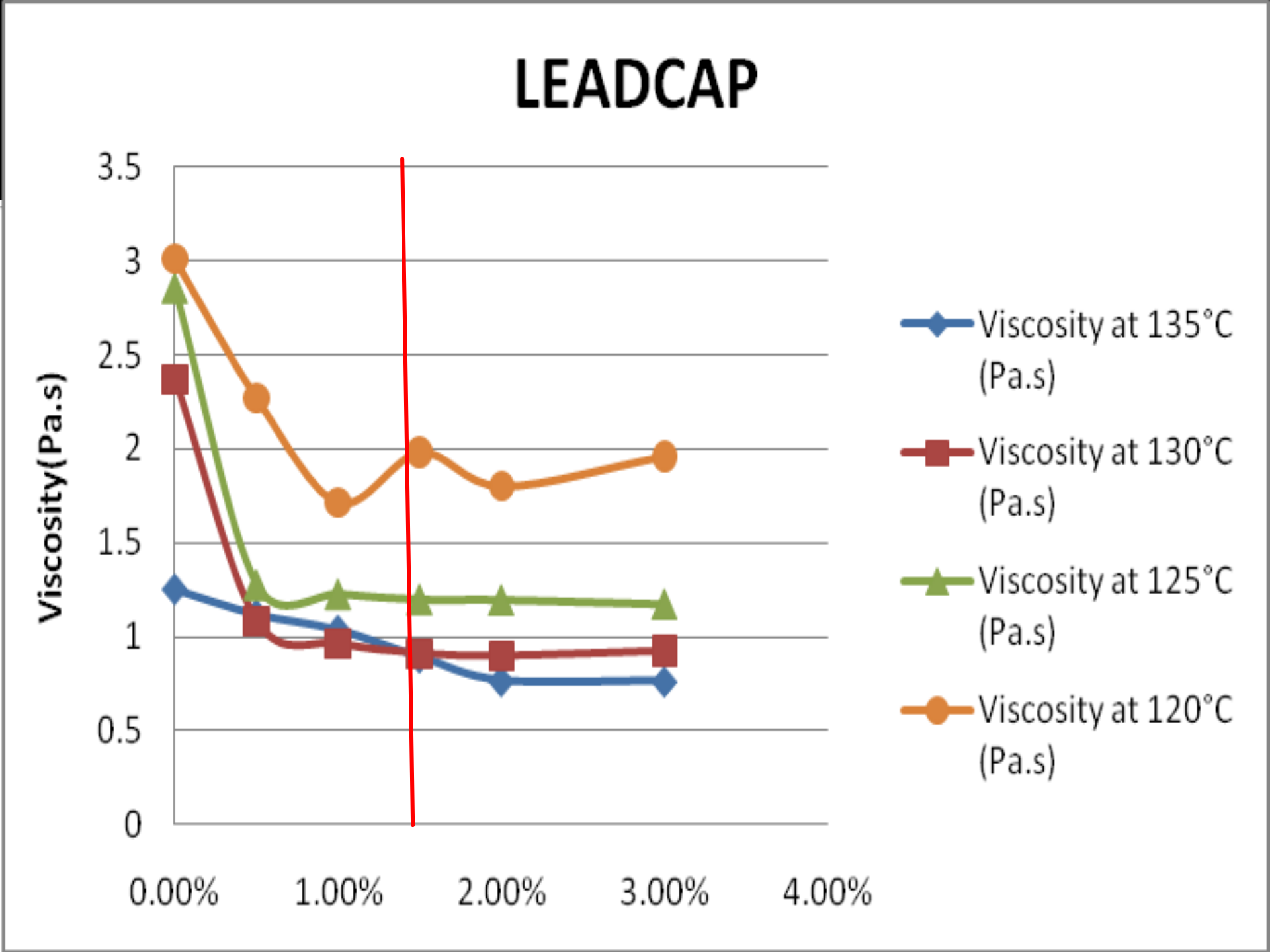
The University of Iowa

PublicPolicy Center

Laboratory for Advanced Construction Technology (LACT)

Need Flexible Warm Mix Asphalt Road

Rigid Concrete Road After Flood in Iowa City

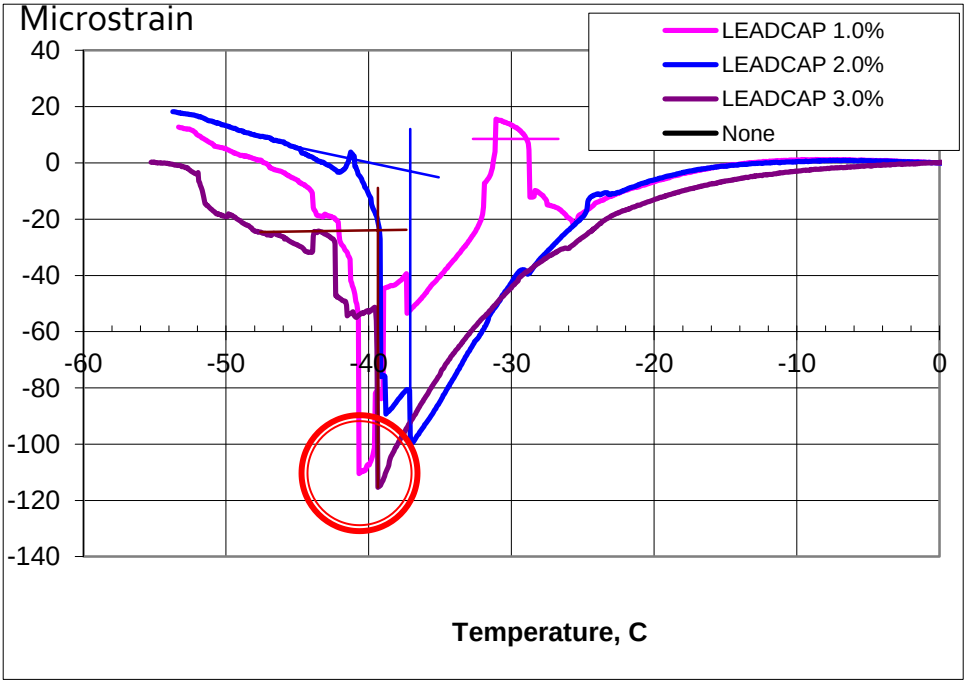

LEADCAP
Viscosity(Pa.s)
3.5
3
2.5
2
1.5
1
0.5
0
0.00%
1.00%
2.00%
3.00%
4.00%
Viscosity at 135°C (Pa.s)
Viscosity at 130°C (Pa.s)
Viscosity at 125°C (Pa.s)
Viscosity at 120°C (Pa.s)

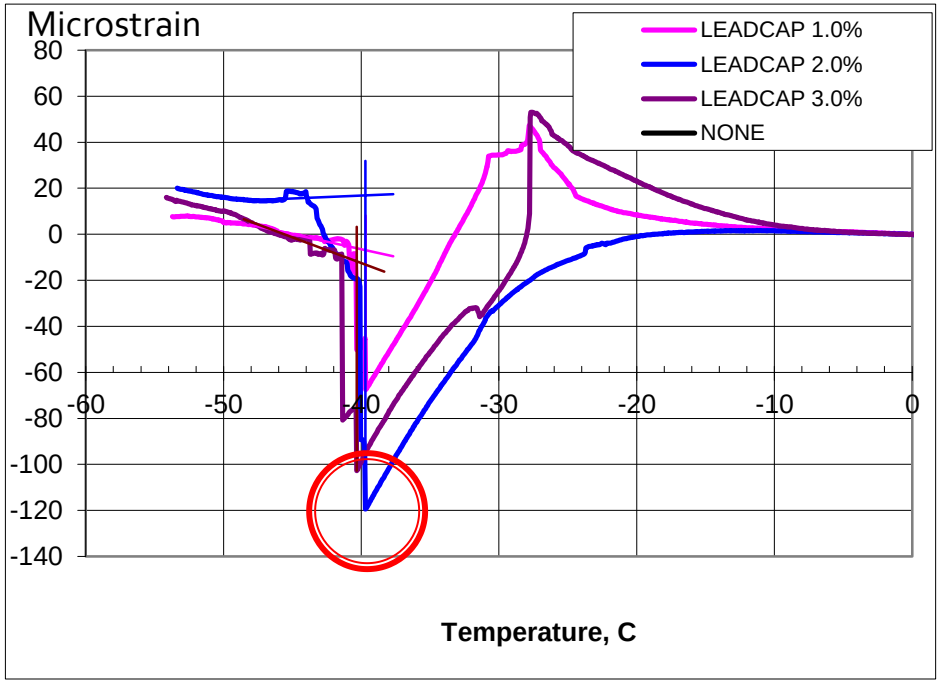
Asphalt Binder Cracking Device

No Change in Cracking Temperature of PG 64-28 with LEADCAP

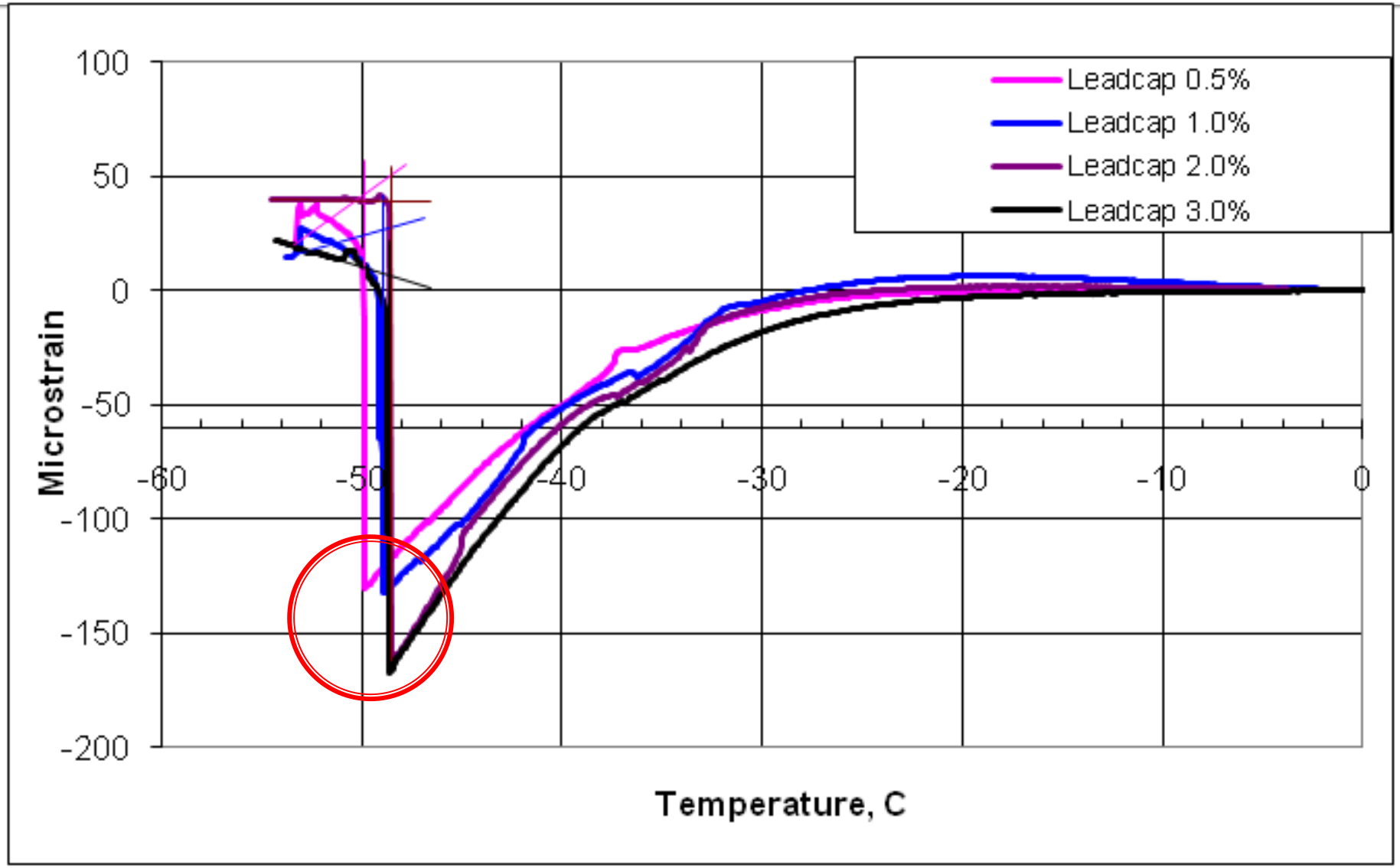
	LEADCAP 1.0%	LEADCAP 2.0%	LEADCAP 3.0%
Crack Temperature (C)	-40.7	-36.9	-39.4
Strain Jump (me)	110.5	99.4	115.3
Cooling Rate (C/hr)	-21.6	-21.1	-20.8

	LEADCAP 1.0%	LEADCAP 2.0%	LEADCAP 3.0%
Crack Temperature (C)	-39.7	-39.7	-40.3
Strain Jump (me)	67.5	119.5	102.7
Cooling Rate (C/hr)	-21.6	-21.0	-20.5



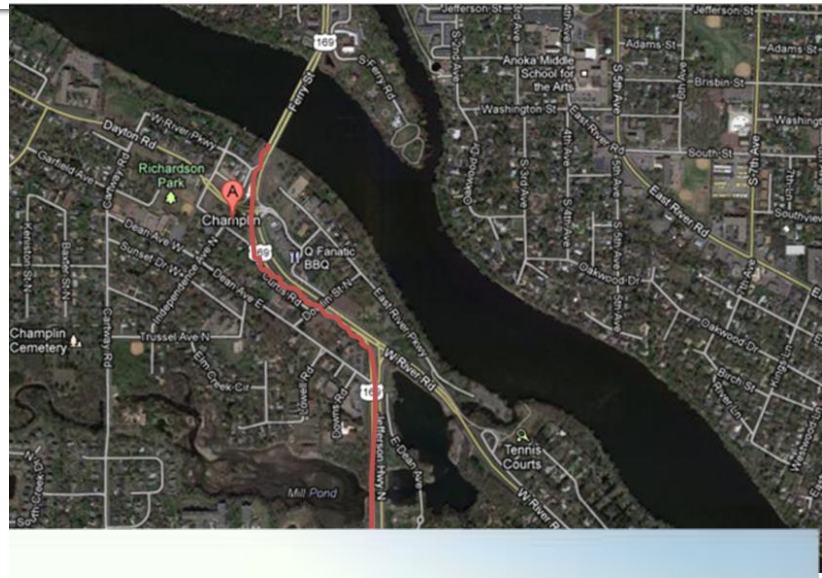


No Change in Cracking Temperature of PG 64-34 with LEADCAP



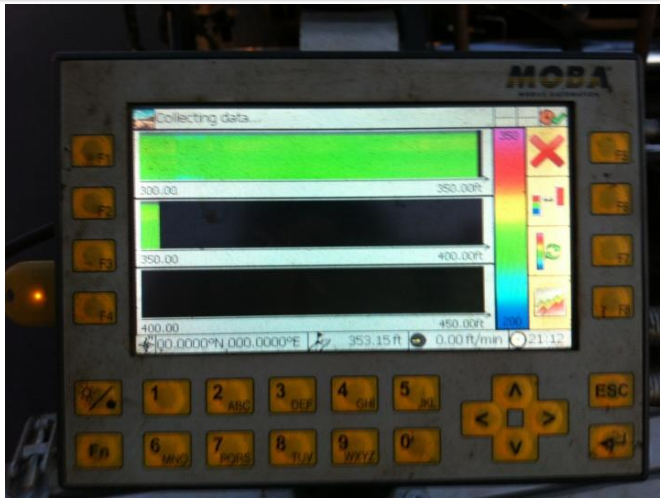
TH 169 State Highway in Champlin, Minnesota on July 10, 2012

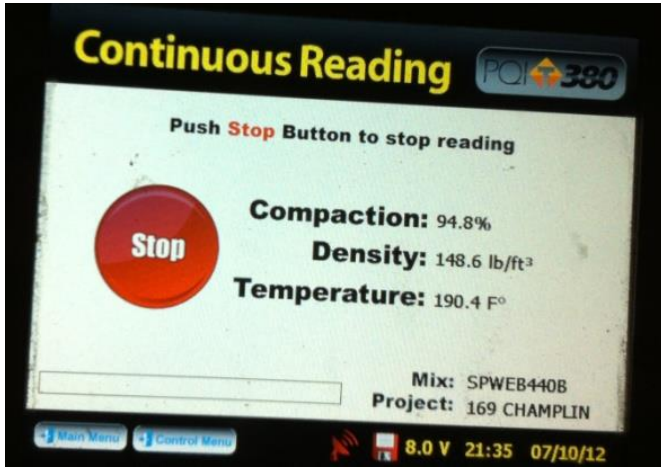
- 2-inch mill and overlay was applied on southbound outside lane of TH 169 State Highway.
- Superpave mix with 5.4% PG 64-28 binder for 3-10 million ESALs was used along with 25% RAP.
- HMA mixture temperature was produced at 160 °C (320°F) whereas the WMA was produced at 135 °C (275°F).



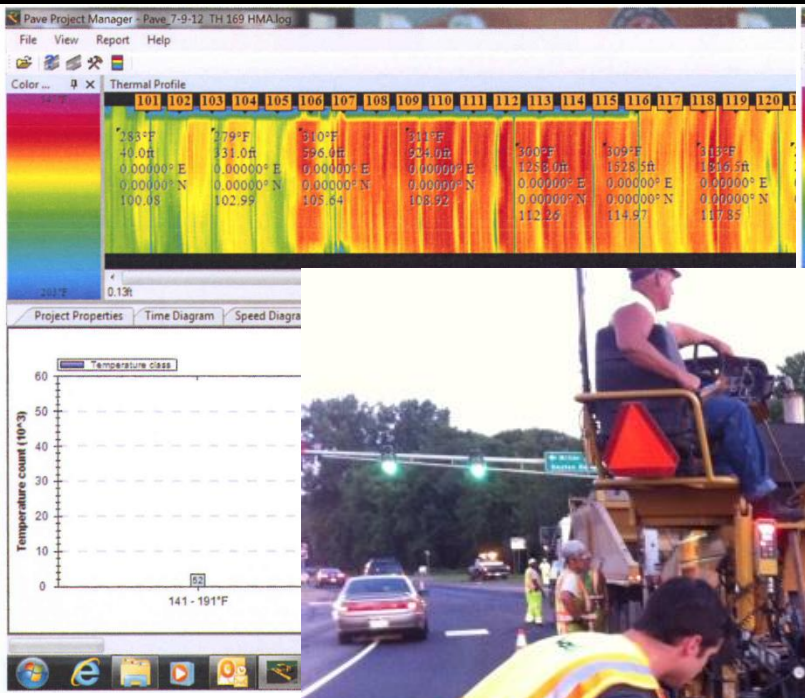
4 Passes for LEADCAP and 93.7% Mat

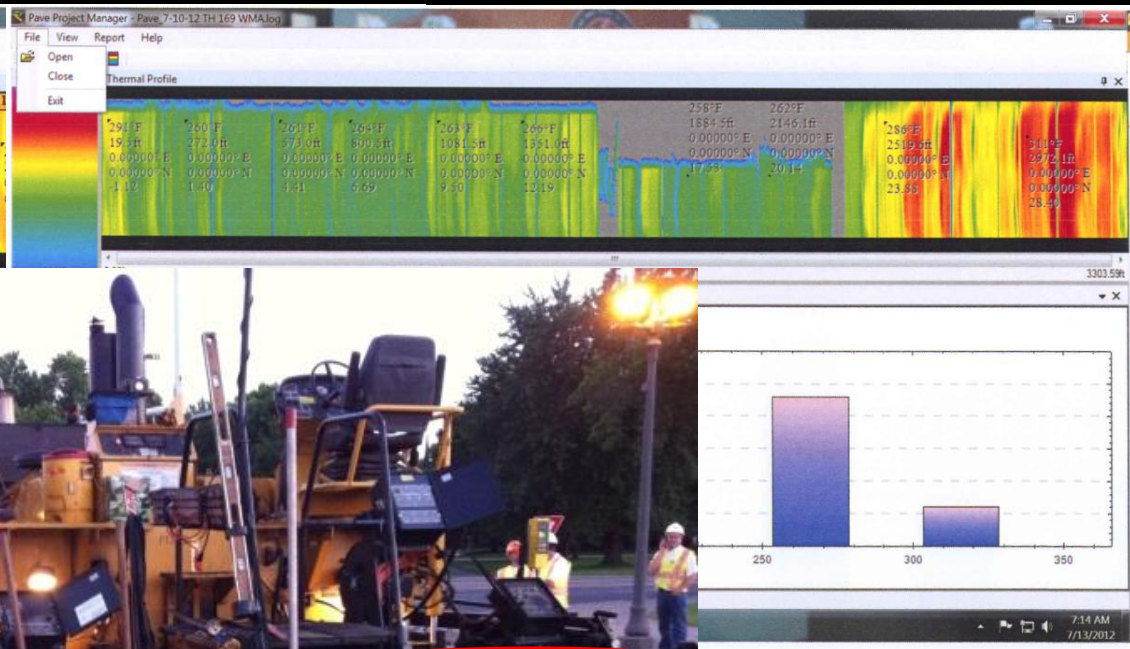
- The mix temperature measured using PAVE-IR device was more consistent with the WMA than the HMA.
- HMA required 6 passes of breakdown roller (vibratory steel double drum), then pneumatic rubber tire and finish rollers. WMA required 4 passes of breakdown roller , then pneumatic and finish rollers to achieve the same density (per PQI non-nuclear device).
- The average density of four LEADCAP WMA cores was 93.7%.





Temperature Gradient of HMA vs. LEADCAP



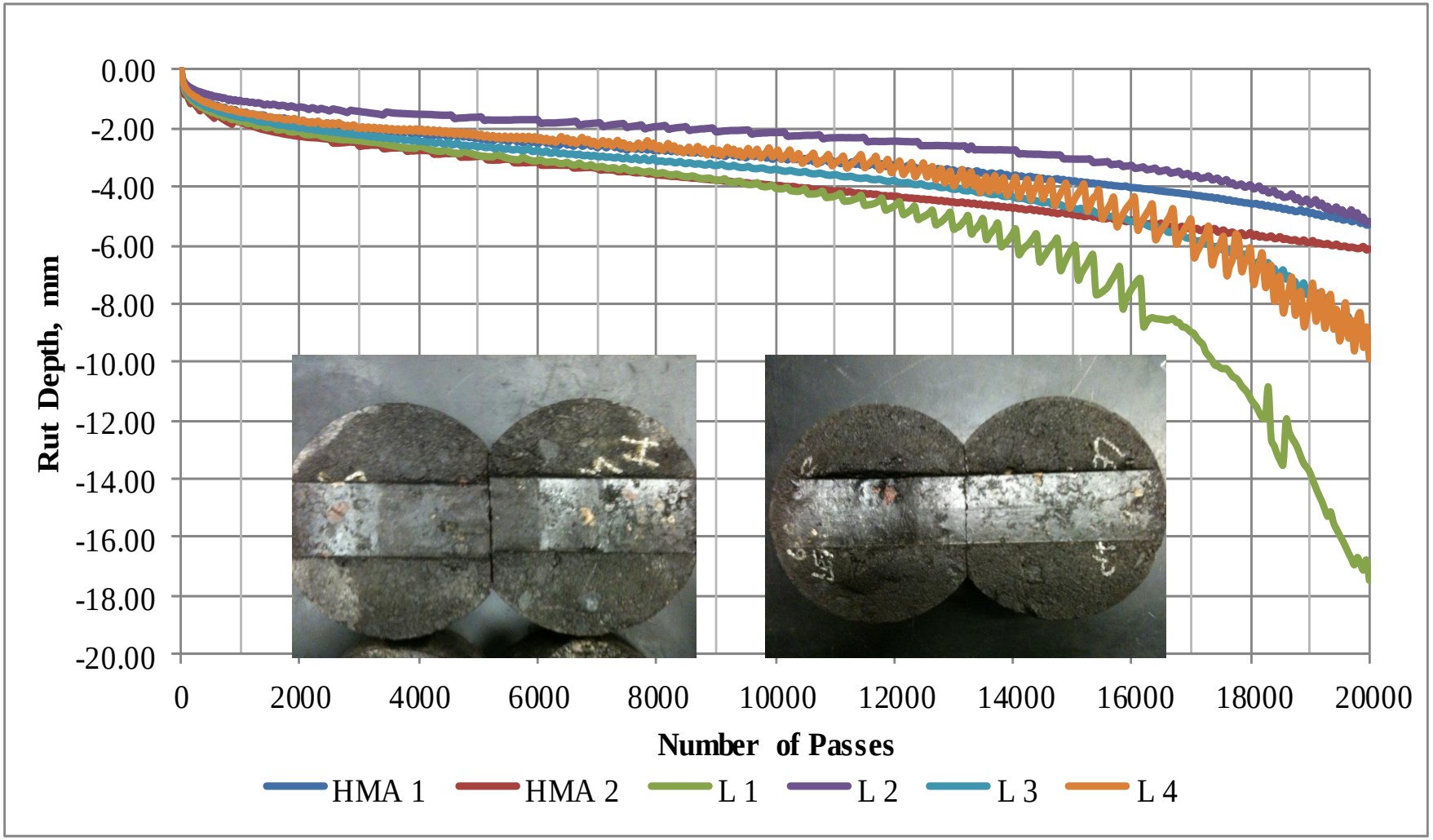


Density of Cores of LEADCAP vs. HMA

Contr.	3.1	54.00	983.7	G	1298.2	315.5	984.4	568.2	982.7	0.2	2.361	94.0
Contr.	3.2	55.00	995.7	H	1307.8	314.0	997.8	566.6	993.8	0.5	2.305	91.8
Agency	3.1C		916.6	13	1147.9	234.2	917.5	530.6	913.7	0.2	2.362	94.0
Agency	3.2C		992.3	14	1209.7	220.8	994.0	560.0	988.9	0.4	2.279	90.7
Contr.	4.1	47.00	859.2	I	1173.1	314.4	860.0	498.2	858.7	0.2	2.373	94.5
Contr.	4.2	56.00	1008.9	J	1325.3	316.9	1009.5	584.3	1008.4	0.1	2.372	94.4
Agency	4.1C		1056.8	15	1292.5	237.7	1057.8	614.0	1054.8	0.2	2.377	94.6
Agency	4.2C		978.8	16	1219.3	242.5	979.5	567.8	976.8	0.2	2.373	94.5
Contr.	1.1	54.00	980.3	A	1298.9	319.0	980.7	573.8	979.9	0.1	2.408	95.6
Contr.	1.2	52.00	939.3	B	1259.5	320.4	939.8	552.9	939.1	0.1	2.427	96.4
Agency	1.1C		910.0	7	1136.4	227.6	910.5	530.8	908.8	0.1	2.393	95.0
Agency	1.2C		932.9	8	1163.9	233.1	933.6	550.5	930.8	0.2	2.430	96.5
Contr.	2.1	45.00	822.1	C	1137.6	316.3	823.0	479.7	821.3	0.3	2.392	95.0
Contr.	2.2	52.00	933.7	D	1249.1	316.2	934.5	533.0	932.9	0.2	2.324	92.3
Agency	2.1C		827.6	9	1063.4	238.4	828.4	478.8	825.0	0.2	2.360	93.7
Agency	2.2C		836.9	10	1081.3	246.9	837.8	474.3	834.4	0.2	2.295	91.1

Hamburg Wheel Tracking Device

Hamburg Test Results of HMA vs. WMA (PG 64-28 with 25% RAP)



State Highway 6 in Iowa City, Iowa on September 9, 2013

- 1.5-inch WMA and 1.5-inch HMA intermediate layer was applied on deteriorated concrete pavement westbound outside lane of State Highway 6.
- Superpave mix with 4.3% PG 64-28 for 10-million ESAL was used along with 38% RAP.
- HMA mixture temperature was produced at 330°F whereas the WMA was produced at 270°F.

Density of Cores of LEADCAP vs. HMA

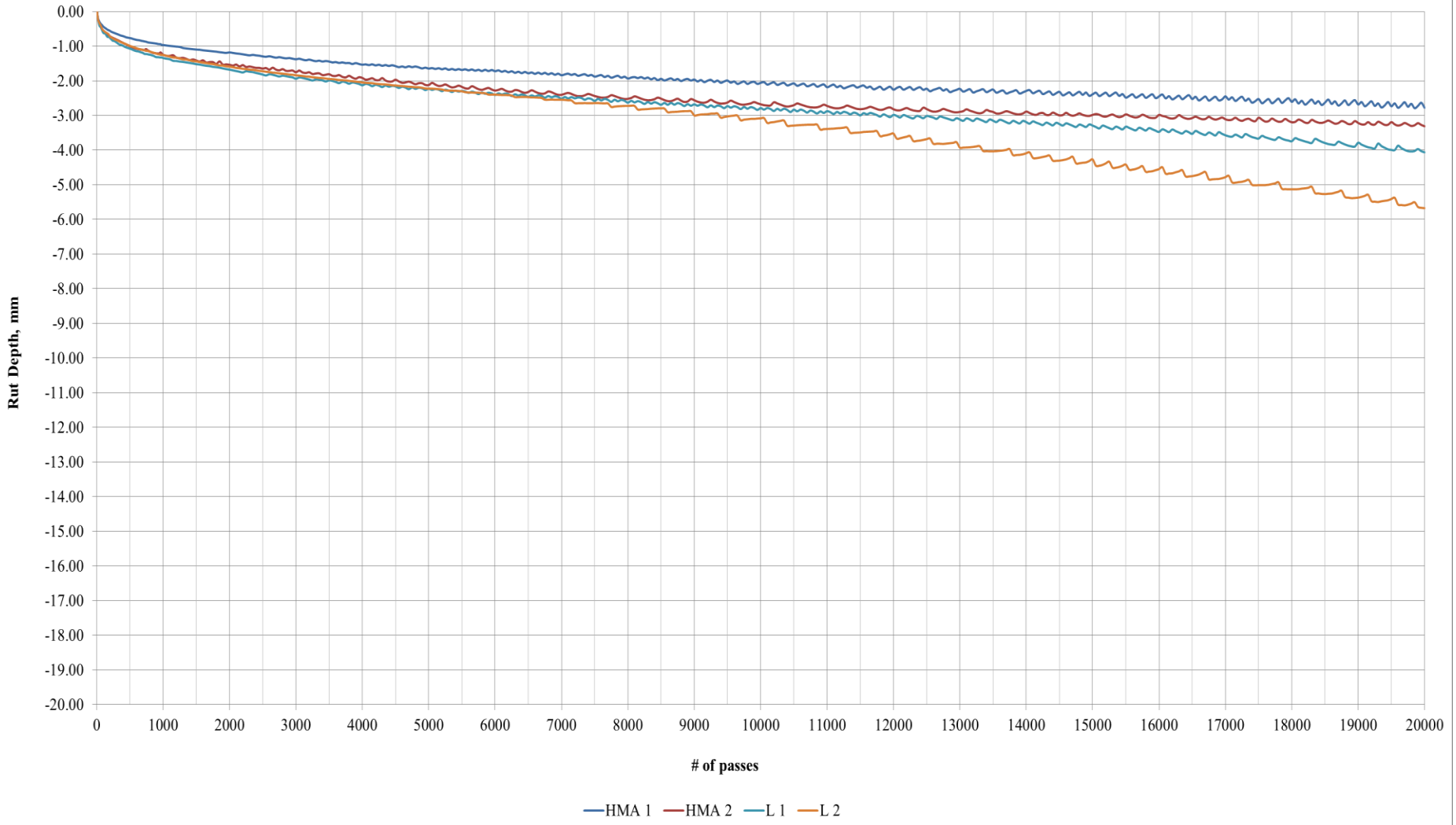
- Average Density of LEADCAP: 93.9%

(6 cores of 92.9, 94.0, 93.3, 94.6, 94.6, 94.1)

- Average Density of HMA: 94.3%

(6 cores of 92.3, 94.6, 95.3, 93.6, 94.4, 95.6)

Hamburg Test Results of HMA vs. WMA (PG 64-28 with 38% RAP)



State Highway 158 in Lancaster, Ohio on August 22 and September 16, 2013

- 3.0-inch WMA overlay was applied (1.25-inch surface and 1.75-inch intermediate layer) on State Highway 158 at Mile post 75.5 Lancaster, Ohio.
- Marshall mix with 4.9% PG 64-22 and 25% RAP intermediate and 6.2% PG 70-22 and 20% RAP surface layer for medium volume of traffic was used.
- HMA mixture temperature was produced at 312°F whereas the WMA was produced at 269°F.

Nuclear Gauge Procedure in Ohio

- Measure Density of Cores of LEADCAP: 96.0% (average of 3 cores of 95.9, 96.4 and 95.6)
- Nuclear Gauge was calibrated based on the average density of the LEADCAP cores
- Nuclear Gauge was then used to measure the density of matt.

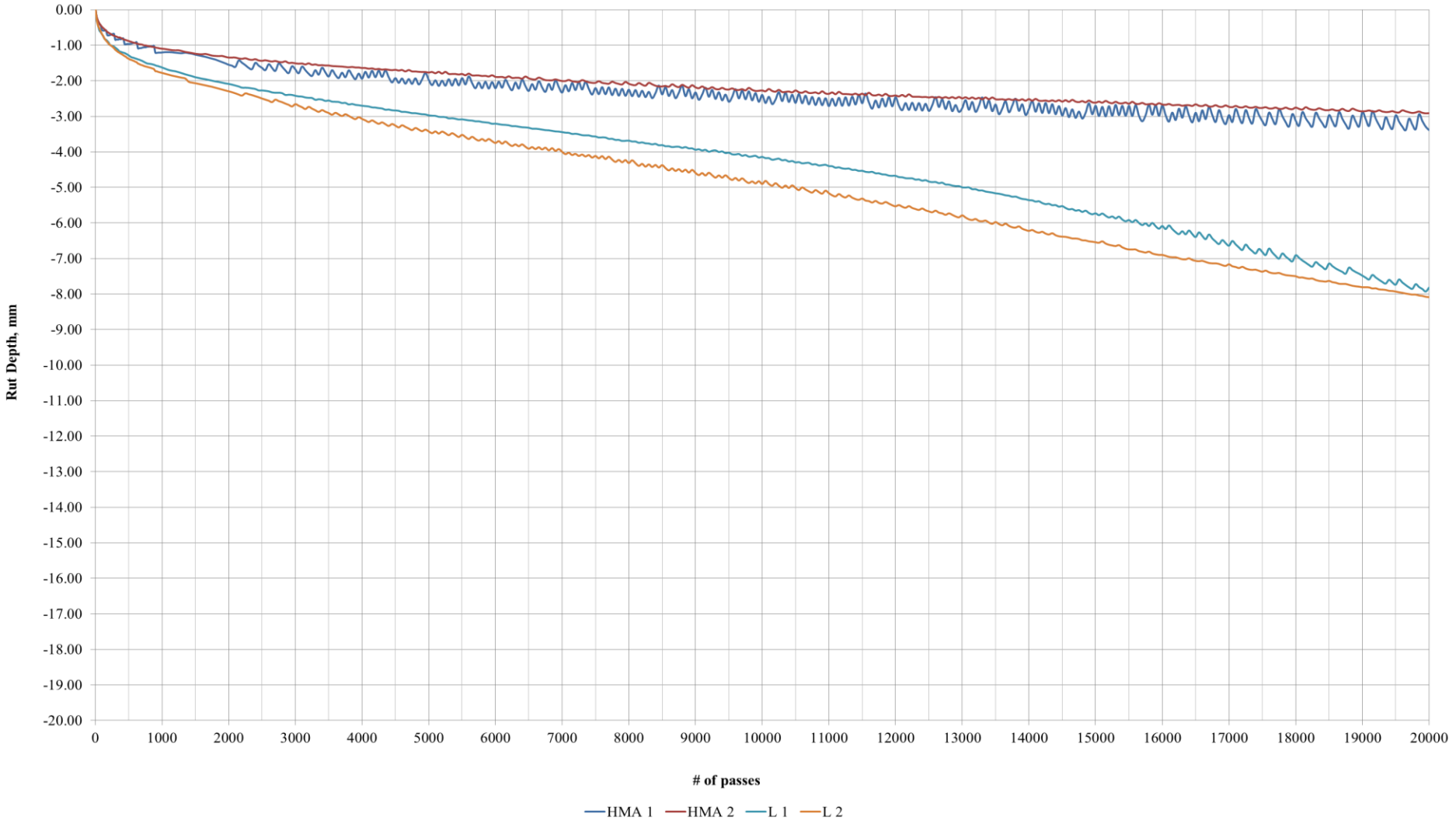
Density of LEADCAP vs. HMA

9/16/13 LEADCAP/Surface	Gauge Reading (Contractor QC)					
Longitudinal Location	Transverse Location				Actal gage Reading, pcf	% Density
336100 NB	L				143.2	95.7
326100 NB	C				144.3	96.5
316100 NB	R				140.9	94.2
306100 NB	L				140.1	93.7
296100 NB	C				143.5	95.9
286100 NB	R				142	94.9
ODOT QA Tests	Pcfs L	C	R	Ave	% Density	ODOT Initials
326100 NB	139.2	144.3	140.9	141.5	94.6	
306100 NB	141.7	144.4	141.6	142.6	95.3	
9/14/13 HMA/Surface	Gauge Reading (Contractor QC)					
Longitudinal Location	Transverse Location				Actal gage Reading, pcf	% Density
376100 NB	L				141.8	95.6
366100 NB	C				142.6	94.1
356100 NB	R				140.9	95
346100 NB	L				141.8	93.6
ODOT QA Tests	Pcfs L	C	R	Ave	% Density	ODOT Initials
356100 NB	144.7	149.1	140.9	144.9	95.6	
346100 NB	141.8	144.7	141.7	142.7	94.2	

95.2

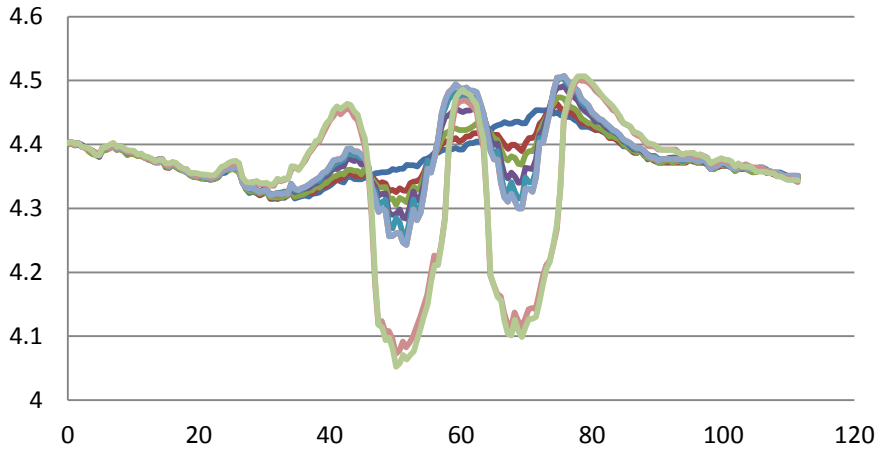
94.1

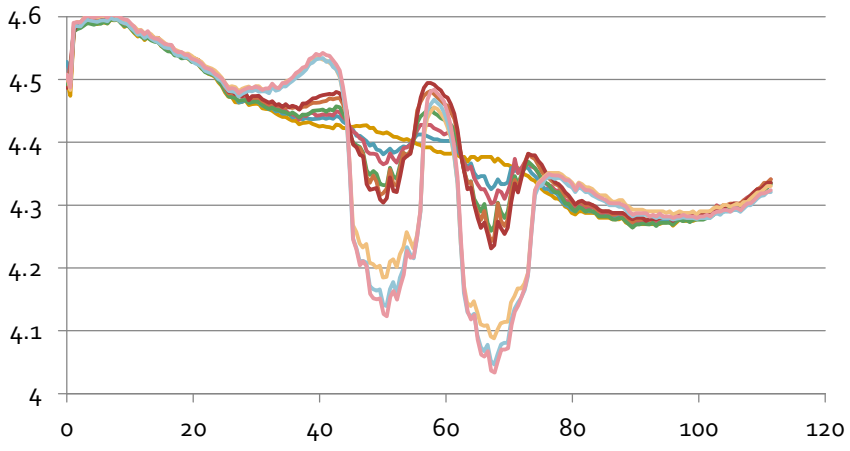
Hamburg Test Results of HMA vs. WMA (PG 70-22 with 20% RAP)



Accelerated 9,000-lb Wheel Loading Test performed on 3-inch LEADCAP PG 70-22 at temperature of 104 °F in November 2012

Rut Profile Nine Measurements after 0, 100, 300, 1,000, 2,000, 3,000, 5,000, 7,000 and 10,000 loadings





Average Rut Depth: 0.319 after 10,000 Loadings

Summary and Conclusions

- LEADCAP lowered the viscosity but did not affect low temperature cracking temperature.
- Mix Temperature of LEADCAP was significantly lower than HMA.
- Hamburg test of LEADCAP field samples from Minnesota, Iowa and Ohio performed well (pretty similar to HMA).
- Density of LEADCAP samples was similar to that of HMA cores achieving about 94-95% density.
- Rutting of LEADCAP test section under the Accelerated Loading Test was acceptable.

Additional Bonus without Penalty if the Contractor Can Meet Density Requirement at Lower Temperature!