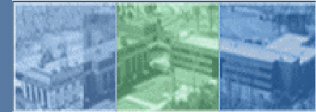


**Asphalt Mix ETG
September 15, 2016
Fall River, MA**

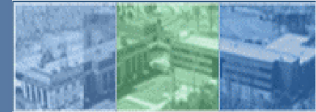
Jack Youtcheff





Evaluation of Asphalt Mixture Cracking Performance Using Monotonic Direct Tension Test in the AMPT

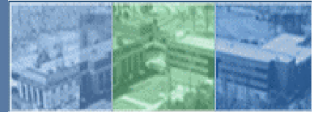




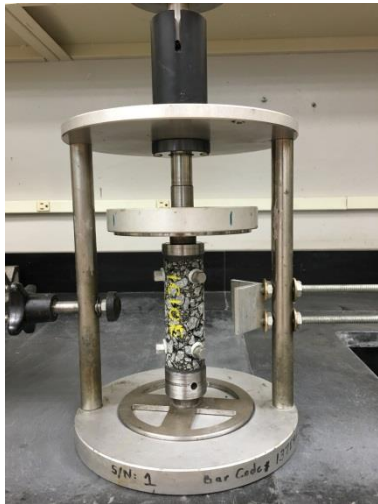
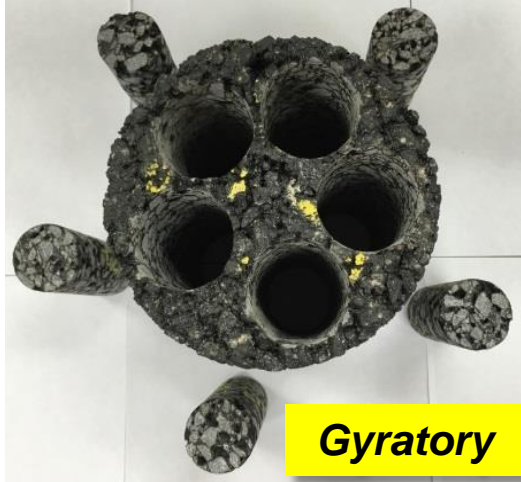
○ Objectives

- **Develop a performance test to quantify cracking resistance**
- **Fast, simple but useful**
- **Ease in sample preparation**
- **Specimen geometry fit for field cores (small size specimen)**
- **Compatible with AMPT**
- **Potential to characterize fatigue damage (S-VECD method)**





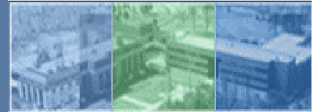
Sample Preparation





Testing Setup





Work Plan

○ **Materials**

- 10 ALF loose mix
- STOA and LTOA
- ALF field cores (under test)

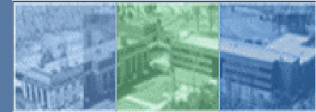
○ **Loading Rates**

- An exploratory research effort (1, 10, 25, 50, 100mm/min)
- This study (1, 10 and 25mm/min)

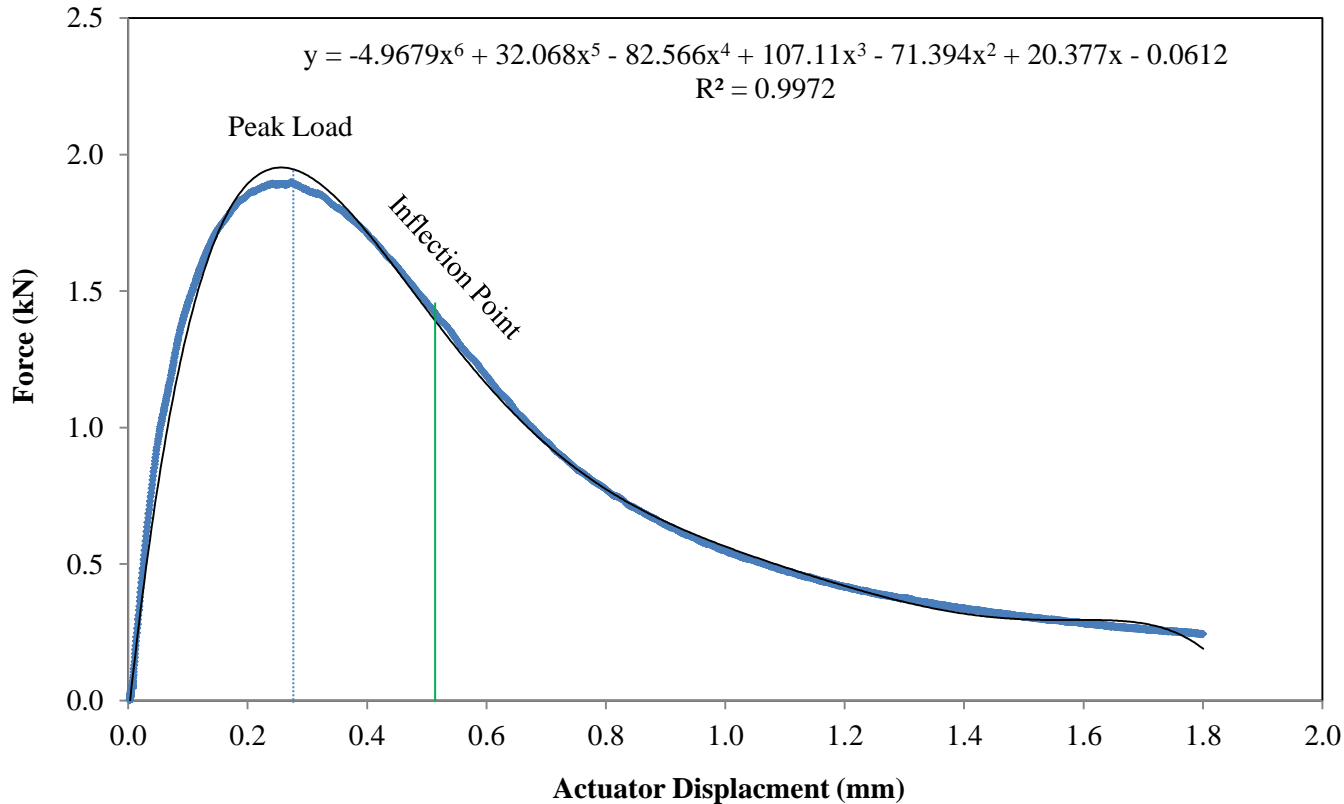
○ **Temperature**

- 12°C
- Minimize visco-plasticity effects
- No need to decomposite strain

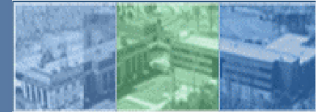




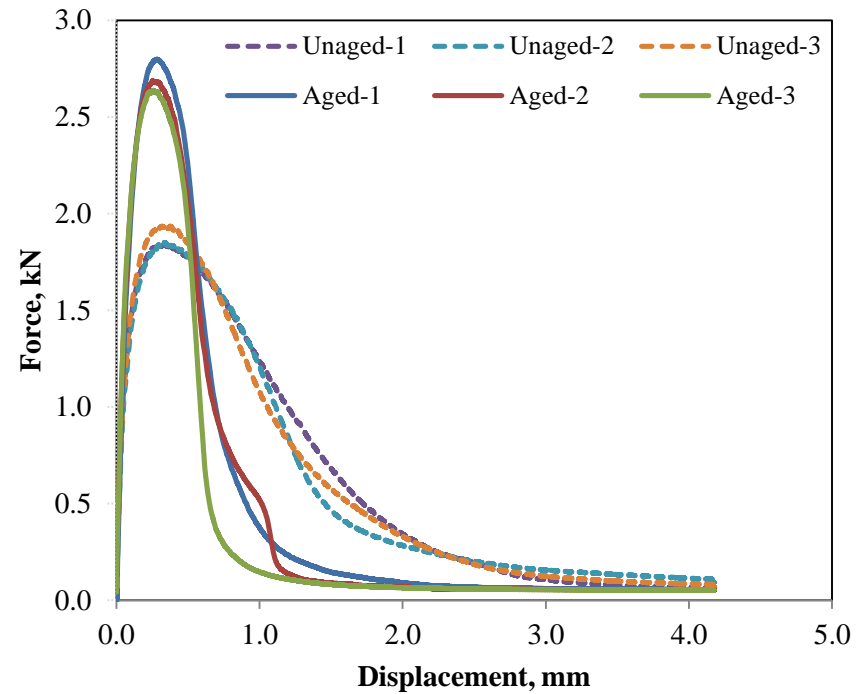
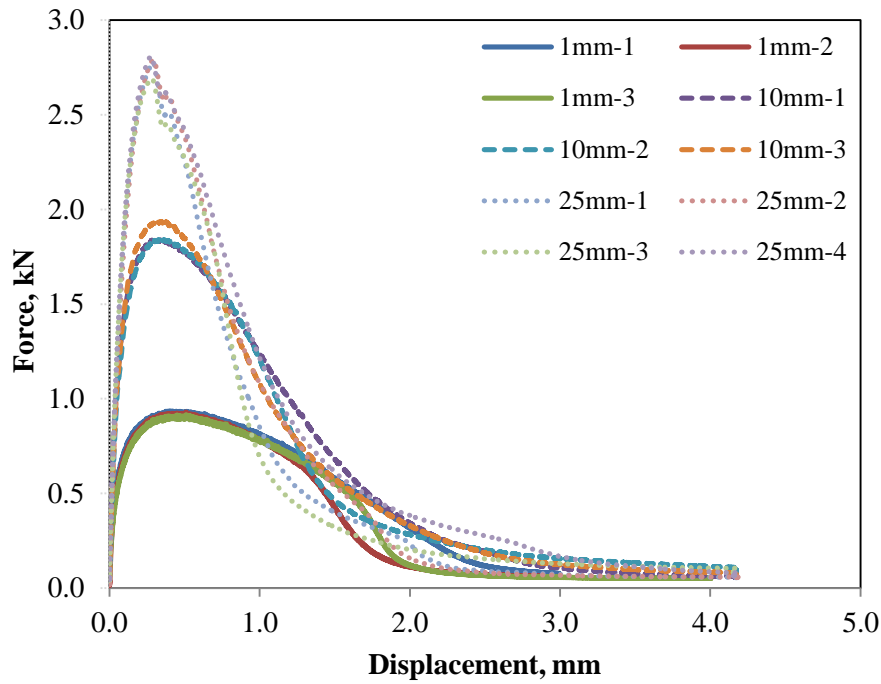
Testing Results



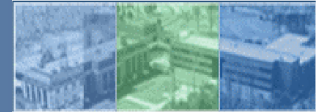
**Tensile Strength, Energy to Peak Load, Total Energy,
Slope at Inflection Point + Derived Indexes**



Testing Results



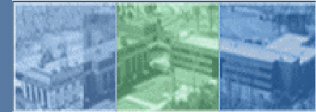
Effect of loading rate and aging condition investigated



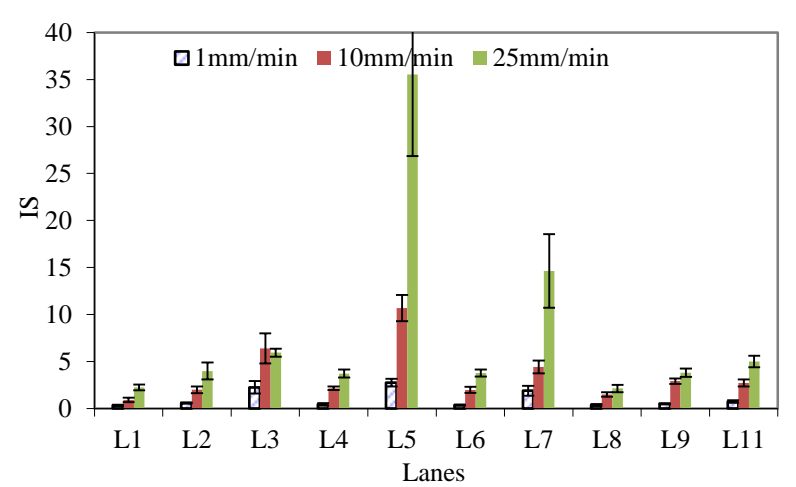
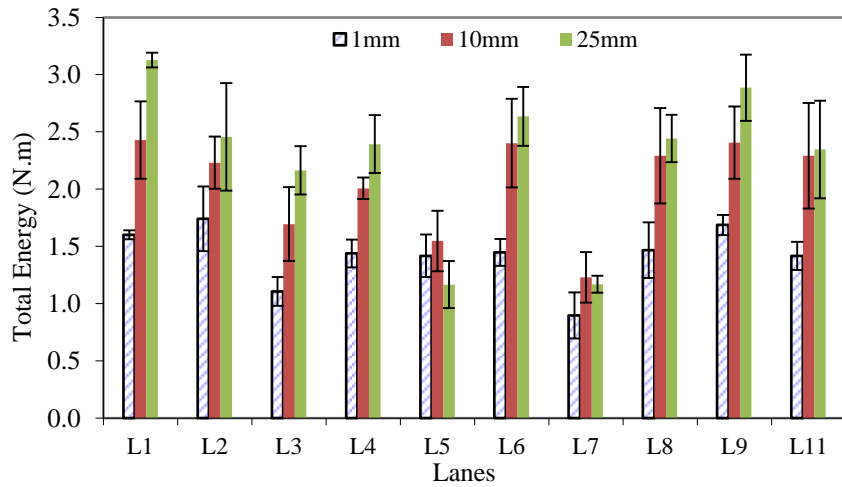
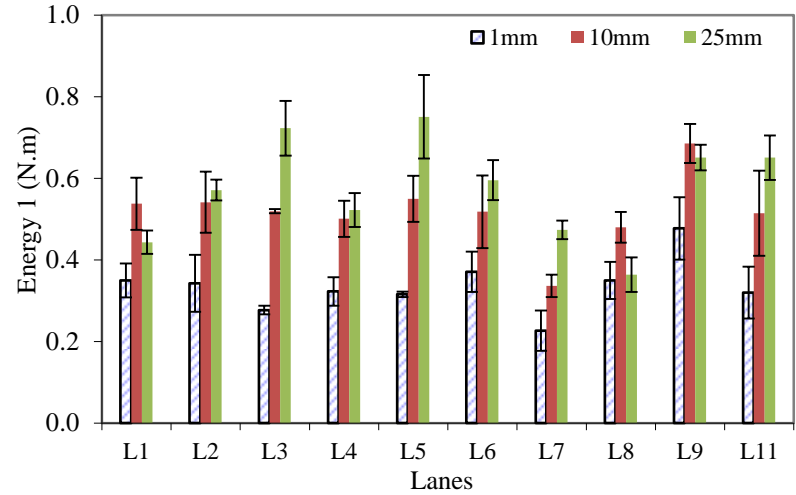
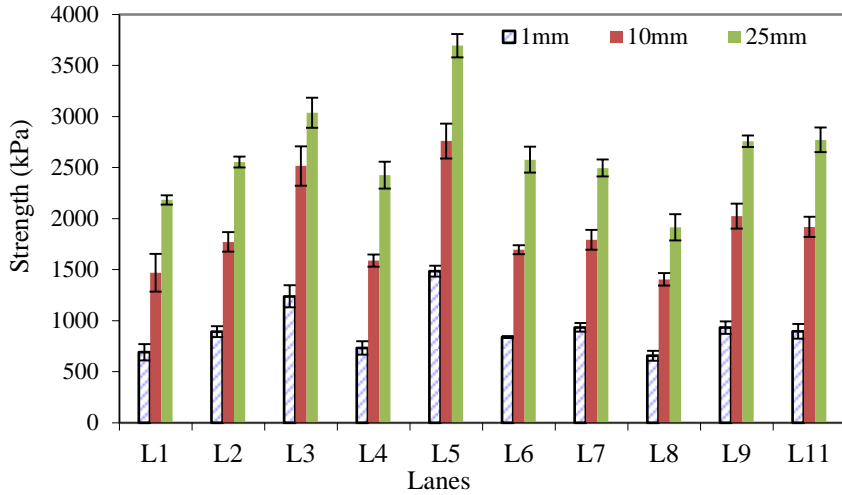
Testing Results

Lane	Strength		E1		E		IS		E1/IS		E/IS		E1/P	E/P
	Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV		
L1	1469	13	0.54	12	2.43	14	0.92	26	64.6	29	281	26	0.33	1.50
L2	1772	5	0.54	14	2.23	10	2.00	18	27.8	21	116	27	0.28	1.14
L3	2516	8	0.52	1	1.69	19	6.40	25	8.5	25	28	43	0.19	0.61
L4	1588	4	0.50	9	2.01	5	2.14	9	23.5	13	94	12	0.29	1.14
L5	2759	6	0.55	10	1.55	17	10.68	13	5.2	20	15	30	0.18	0.51
L6	1695	3	0.52	17	2.40	16	1.98	16	26.9	26	125	27	0.28	1.28
L7	1792	5	0.34	8	1.23	18	4.42	16	7.8	25	29	36	0.17	0.62
L8	1404	4	0.48	8	2.29	18	1.50	16	32.4	10	159	33	0.31	1.48
L9	2024	6	0.69	7	2.41	13	2.91	10	23.6	6	80	19	0.31	1.08
L11	1918	5	0.51	20	2.29	20	2.72	14	18.1	35	85	23	0.24	1.08

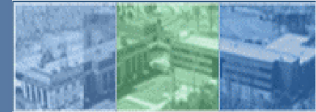
Testing results for STOA at 10mm/min



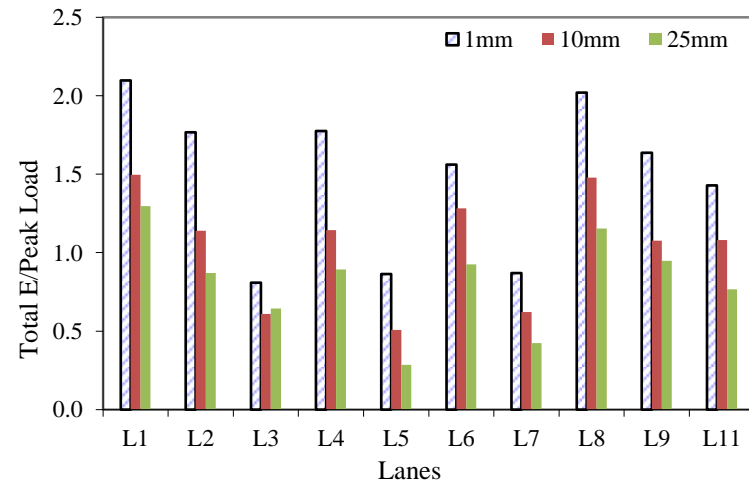
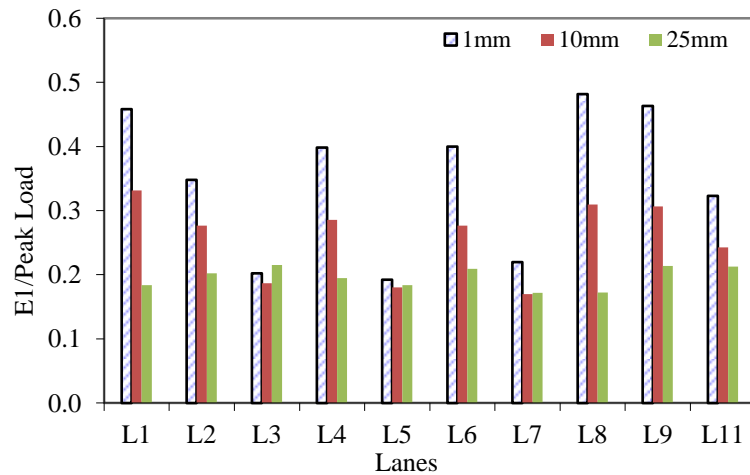
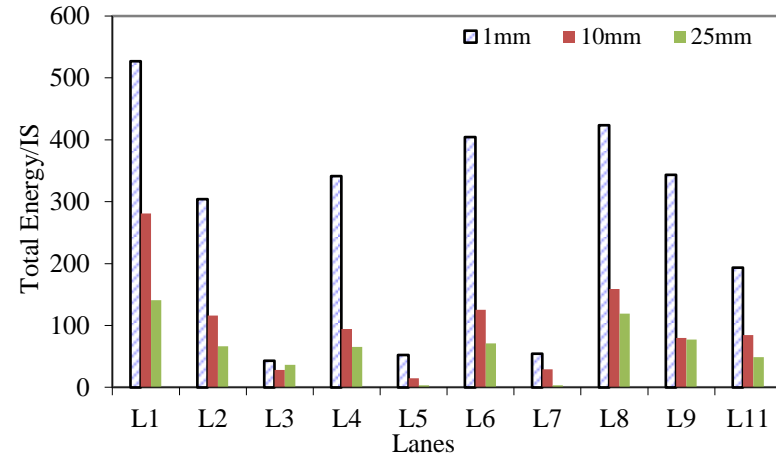
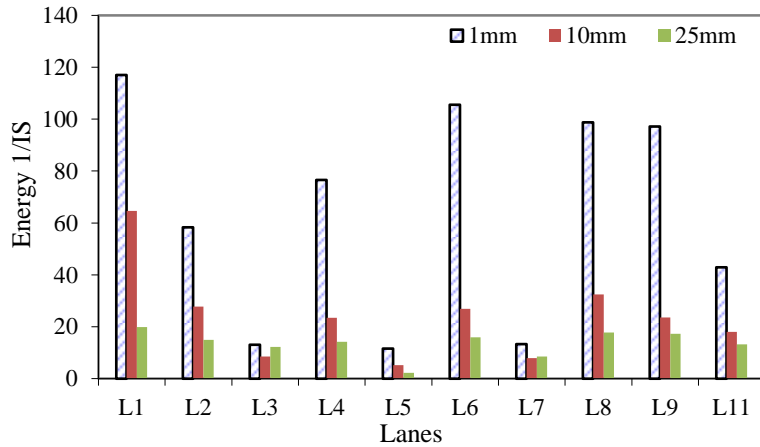
Testing Results



Testing results (parameters) for STOA



Testing Results



Testing results (derived indexes) for STOA



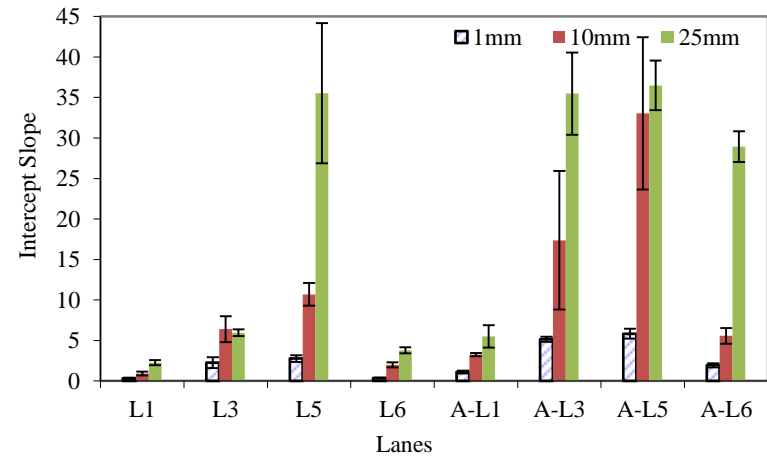
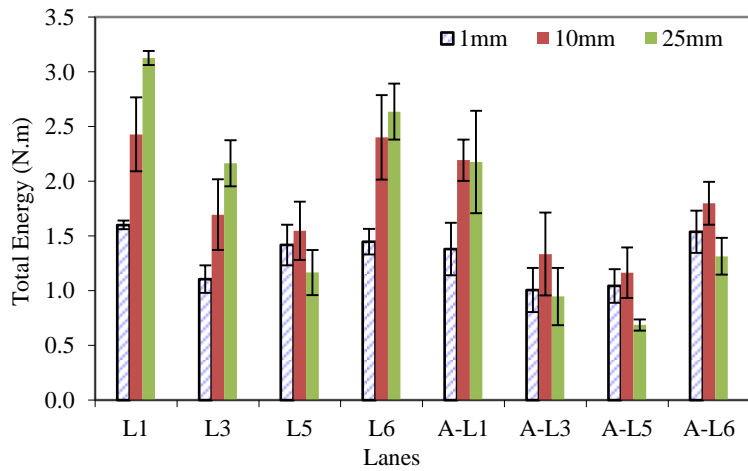
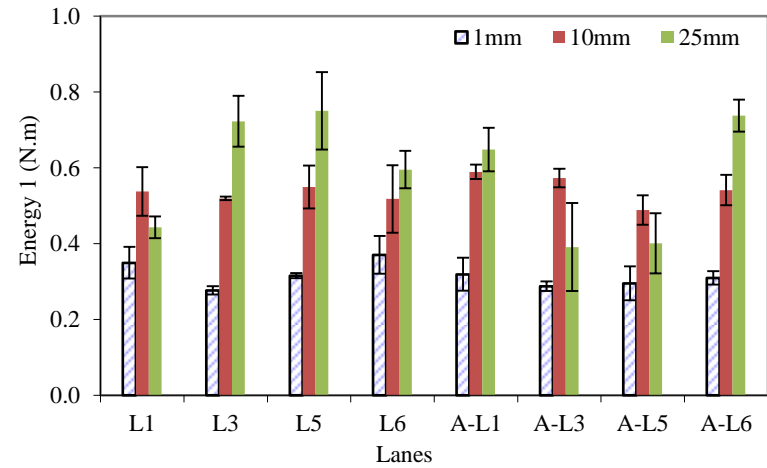
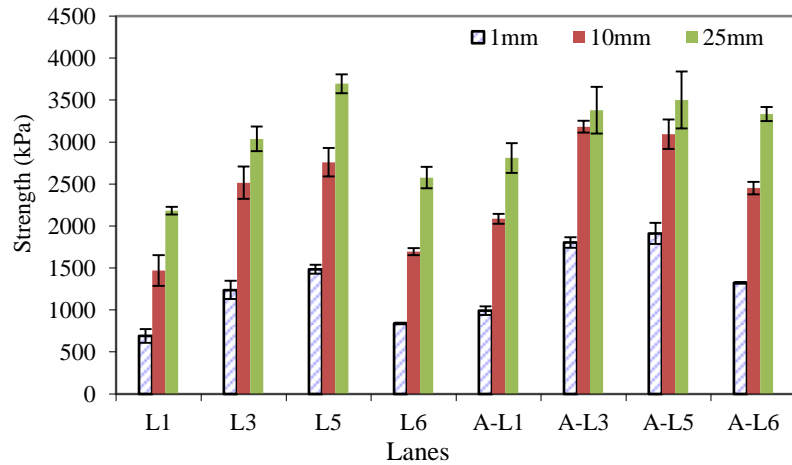
Testing Results

Lane	Loading Rate	Strength		E1		E		IS		E1/IS		E/IS		E1/P	E/P
		Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV	Ave.	COV		
L1	1mm/min	993	5	0.32	14	1.38	17	1.1	17	30.2	27	131.5	35	0.29	1.26
L3		1804	4	0.29	4	1.01	20	5.1	6	5.6	22	19.7	24	0.14	0.51
L5		1913	7	0.30	15	1.04	15	5.8	11	5.1	12	18.2	24	0.14	0.49
L6		1324	1	0.31	6	1.54	13	1.9	13	16.3	26	81.6	27	0.21	1.05
L1	10mm/min	2085	3	0.59	3	2.19	9	3.3	6	18.1	29	67.6	15	0.26	0.95
L3		3182	2	0.57	4	1.33	28	17.4	31	3.8	25	9.4	30	0.16	0.38
L5		3093	6	0.49	8	1.16	20	33.0	28	1.6	20	3.9	31	0.14	0.34
L6		2452	3	0.54	7	1.80	11	5.6	18	9.9	26	33.3	25	0.20	0.66
L1	25mm/min	2810	6	0.65	9	2.18	21	5.5	25	12.4	13	43.3	43	0.21	0.70
L3		3379	8	0.39	30	0.95	28	35.5	14	1.1	7	2.8	41	0.10	0.25
L5		3501	10	0.40	20	0.69	8	36.5	8	1.1	35	1.9	8	0.10	0.18
L6		3335	3	0.74	6	1.31	13	28.9	7	2.6	9	4.6	19	0.20	0.36

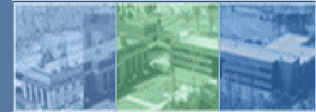
Testing results for LTOA



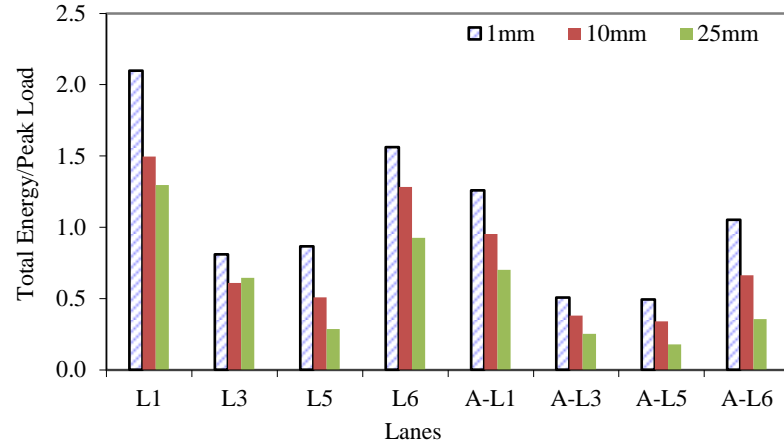
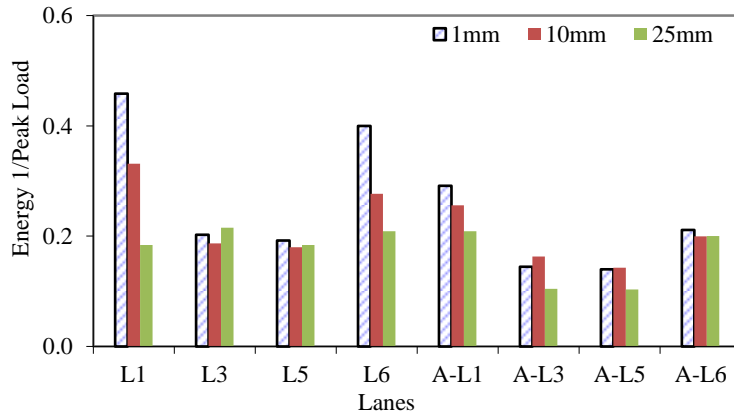
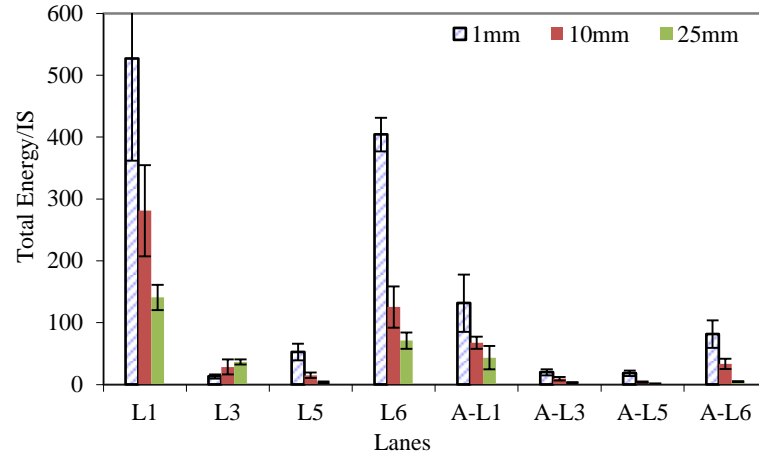
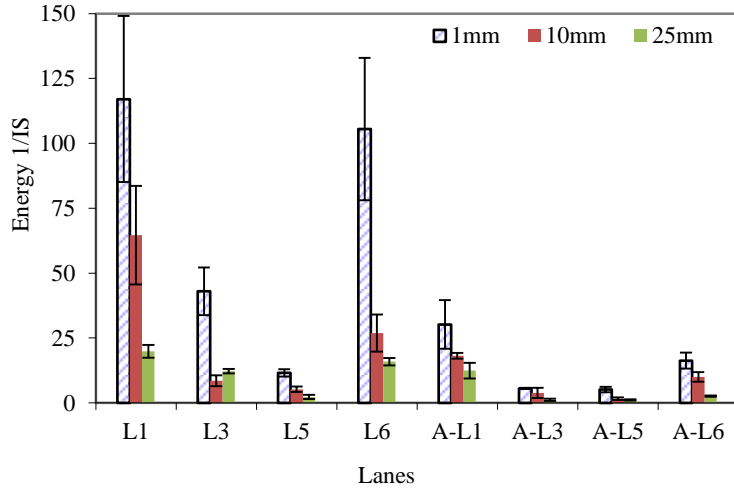
Testing Results



Testing results (parameters) for LTOA

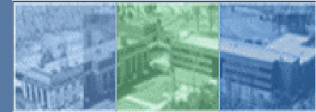


Testing Results

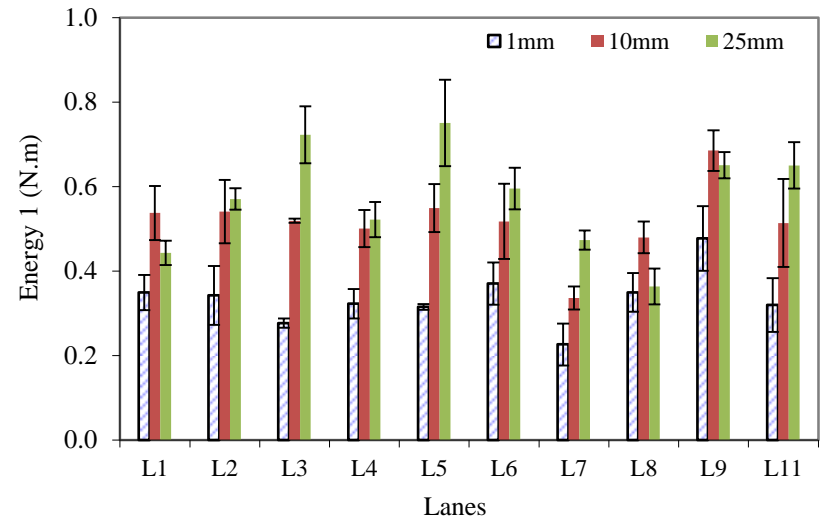
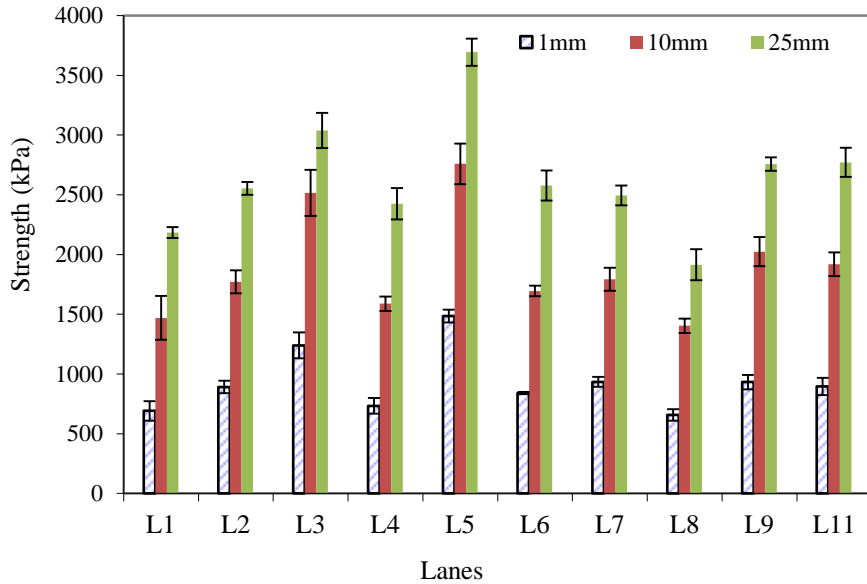


Testing results (derived indexes) for LTOA

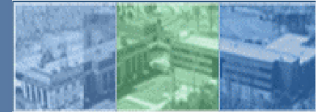




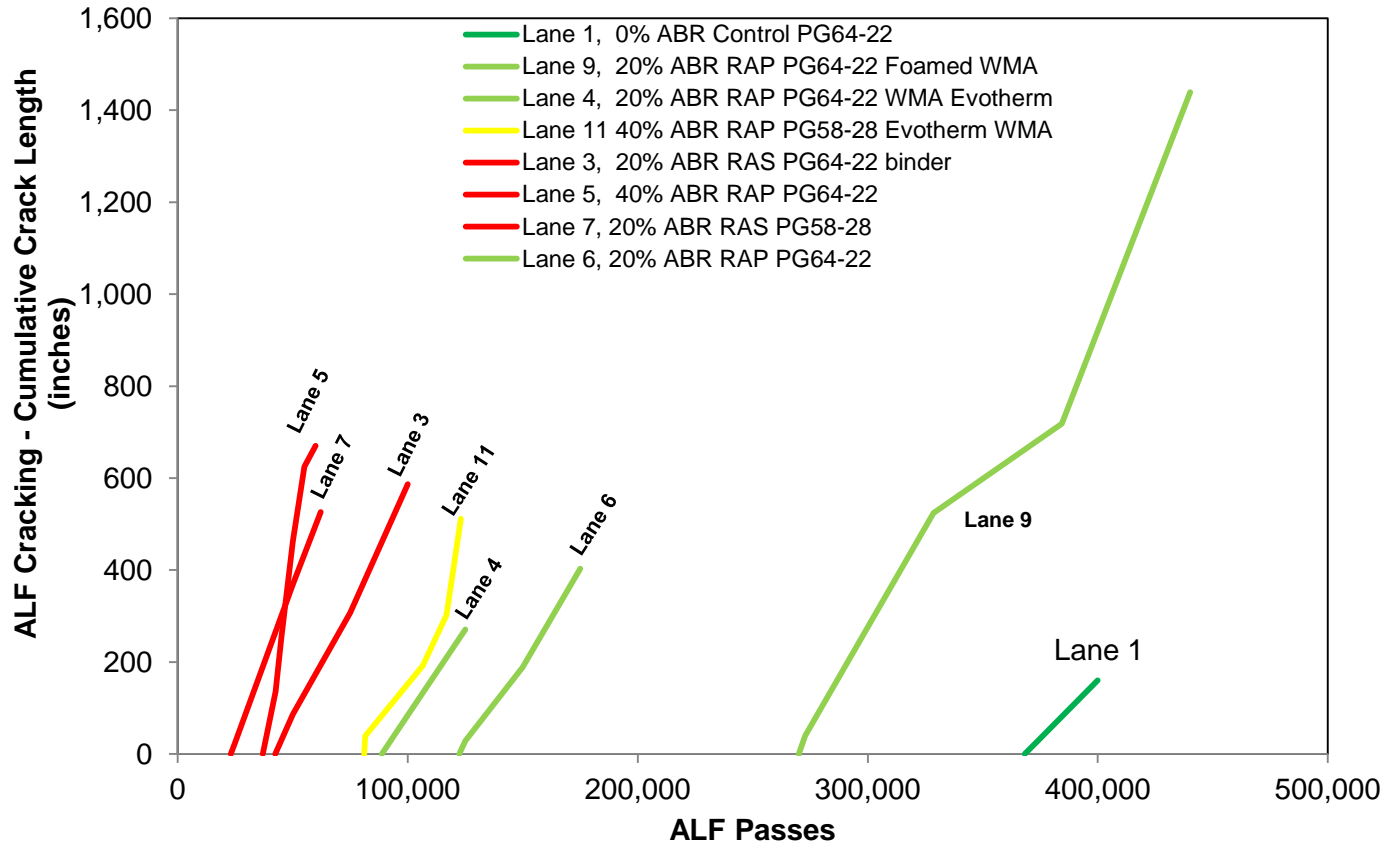
Testing Results



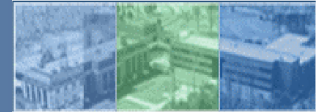
Effect of loading rate and aging condition investigated



ALF Field Cracking Performance



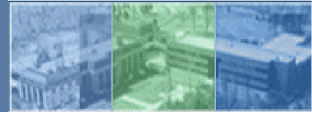
Eight lanes finished testing, L2 delayed and L8 incomplete



Correlate Laboratory Test to Field Cracking Performance

○ Statistical Method (Kendall's Tau)

Loading Rate	Strength	E 1	Total E	E1/IS	Total E/IS	E1/ Peak Load	Total E/ Peak Load
1 mm/min	-0.57	0.79	0.86	0.86	0.71	0.79	0.71
10 mm/min	-0.43	0.29	0.93	0.86	0.64	0.93	0.71
25 mm/min	-0.43	-0.29	1.00	0.93	1.00	0.14	0.93



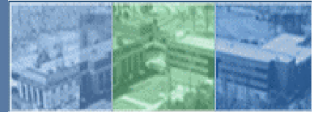
Current Status

- **Paper on loose mix data submitted to AAPT**
- **Field core testing is underway**



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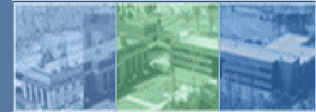
FWHA High RAP (RAS) + WMA Accelerated Pavement Test





ALF Experimental Design

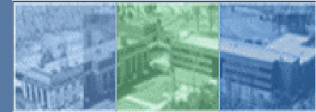
HMA / WMA Drum Discharge Temperature Warm Mix Technology		300°F - 320°F		240°F - 270°F			
		-		Foam	Chem.		
Recycle Content		0%		-	-		
		20% ABR RAP ≈ 23% by weight		✓ PG64-22	✓ PG64-22	✓ PG64-22	
Recycle Content		20% ABR RAS ≈ 6% Shingle by weight		✓ PG64-22	✓ PG58-28	-	-
		40% ABR RAP ≈ 44% by weight		✓ PG64-22	✓ PG58-28	✓ PG58-28	✓ PG58-28



Loose Mix Testing

- **Dynamic Modulus**
 - Full Size
 - Reduced Size
- **Fatigue (AASHTO TP 107)**
 - Full Size
 - Reduced Size
- **Monotonic Direct Tension**
 - Reduced Size
- **Aging**
 - AASHTO R30 (loose mix)





Core Sampling Timeline

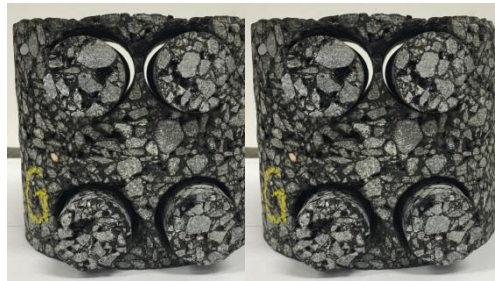
2013



t = 0m
Top
Bottom



2014



t = 6m
Top



t = 12m
Top
Bottom



2015



t = 24m
Top
Bottom



2016



t = 36m
Top
Bottom

Will Do

Will Do

Will Do

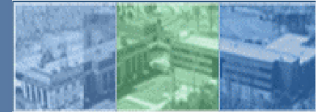
Cores Taken

Testing Done

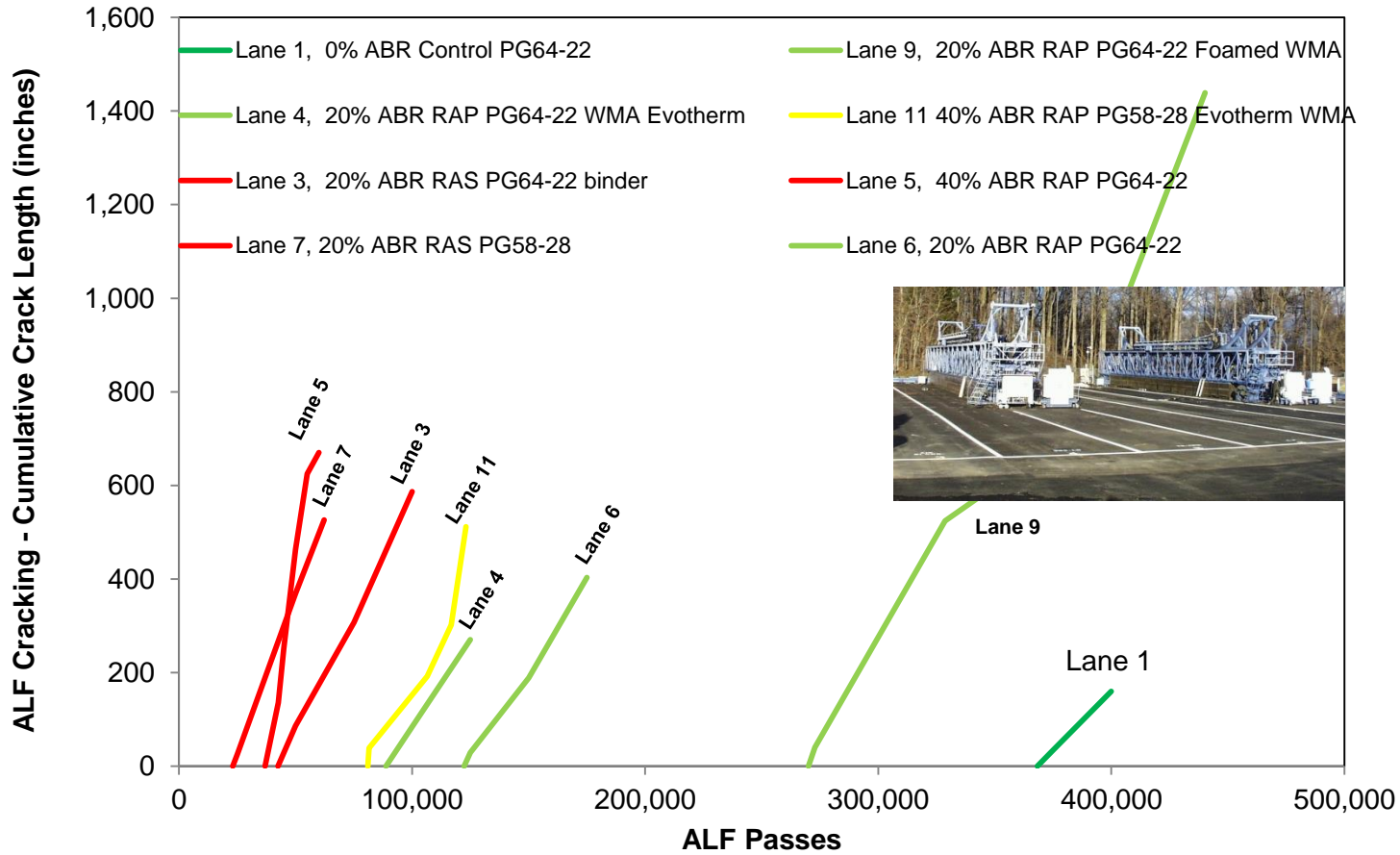
Data Analysis

Will Do

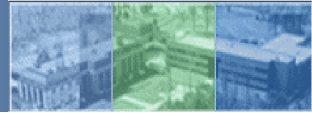
Will Do



ALF Field Testing



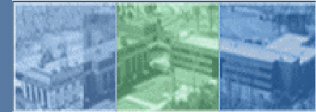
Eight lanes finished testing, L2 delayed and L8 incomplete



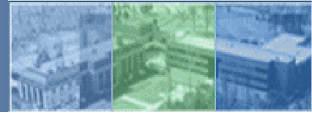
Next Steps

- **Will be conducting performance tests on 40% RAS & RAP-BR + 0.5%, +0.75%, +1.0% binder.**
- **Will determine how much binder needs to be added for RAS & 40% RAP-BR mixes to exhibit equivalent performance.**
- Which mix is the reference mix that should be the equivalent performance target? 0% or 20% RAP-BR?





PAVEMENT TESTING FACILITY (PTF)



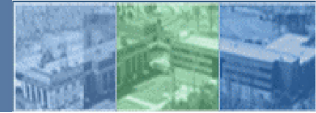
Current Experiment

RECLAIMED ASPHALT PAVEMENT



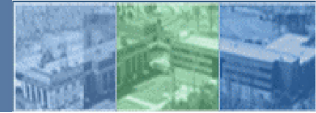
Purpose

- Advance Use of Recycled Asphalt in Flexible Pavement Infrastructure: Develop and Deploy Framework for Proper Use and Evaluation of Recycled Asphalt in Asphalt Mixtures



Objective

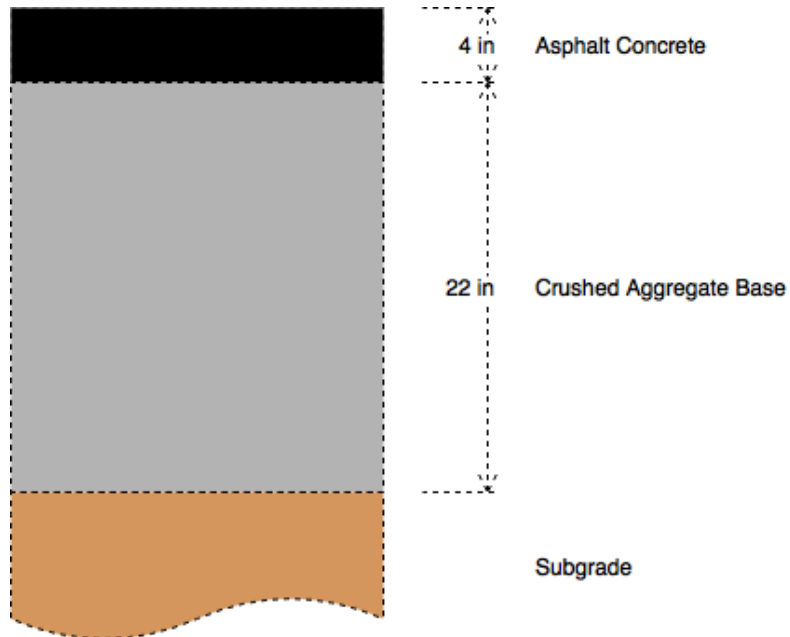
- Quantify cracking resistance of high Recycled Asphalt Pavement (RAP) mixtures that considers the use of lower temperature production with warm-mix asphalt (WMA); Investigate limitations and provide recommendations for combining the two technologies



The Experiment

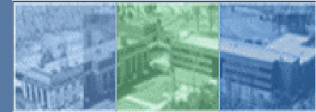
Structure

- 10 Lanes (10 Mixes)
- Build in 2013



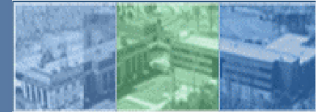
Materials

- 2 Binder Grades
- 2 Mix Types
- 2 WMA Technologies
- 3 RAP contents



ALF Experimental Design

HMA / WMA Production Temperature		300°F - 320°F			240°F - 270°F	
		-		Foam	Chem.	
Warm Mix Technology		PG64-22		-	-	
		PG64-22		PG64-22	PG64-22	
Recycle Content		PG64-22	PG58-28			
		PG64-22	PG58-22	PG58-22	PG58-22	
0%		PG64-22		-	-	
20% ABR RAP ≈ 23% by weight		PG64-22		PG64-22	PG64-22	
20% ABR RAS ≈ 6% Shingle by weight		PG64-22	PG58-28			
40% ABR RAP ≈ 44% by weight		PG64-22	PG58-22	PG58-22	PG58-22	

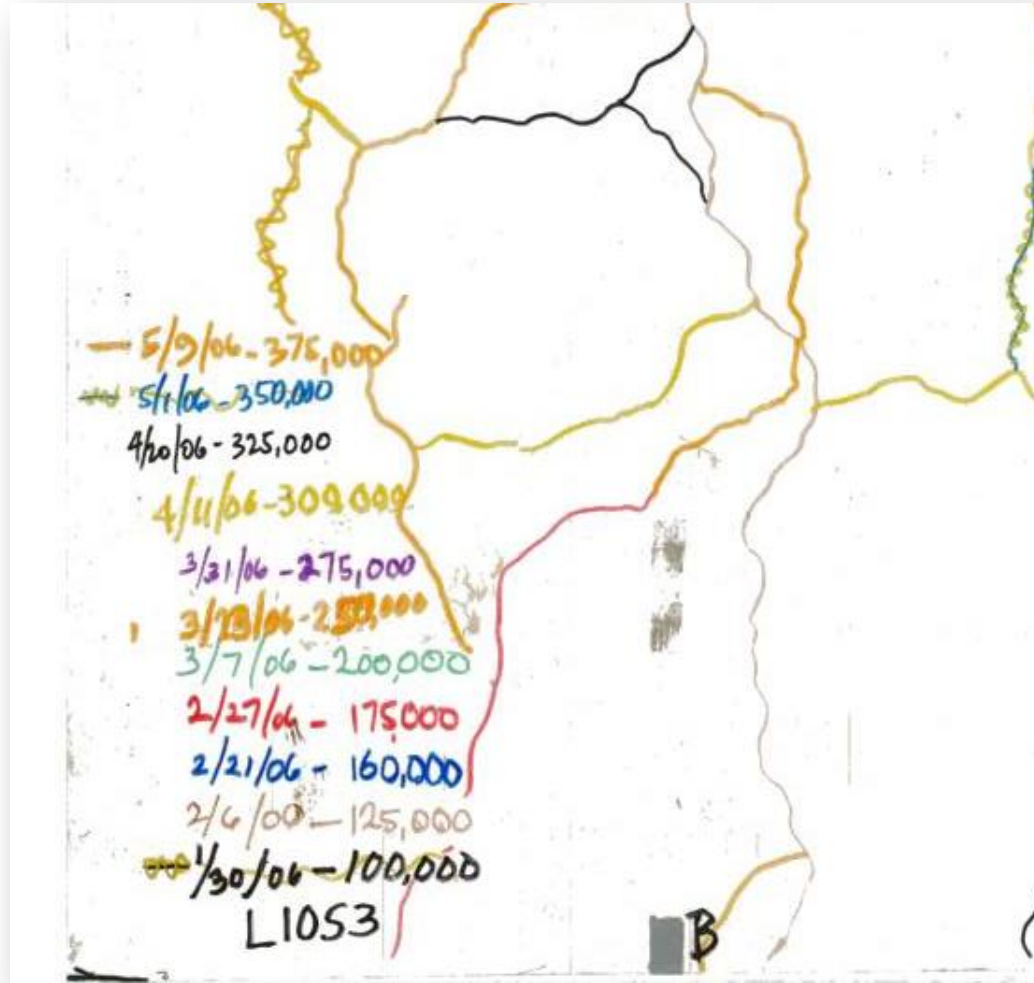


Loading Conditions

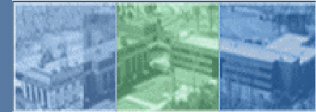
- Tire
 - 425/65R22.5 wide base
 - Tire pressure: 100 psi
- Total load: 14,200 lbf
- Speed = 11 mph (4.9 m/s)
- Isothermal at 20°C (target temperature at AC mid-thickness)



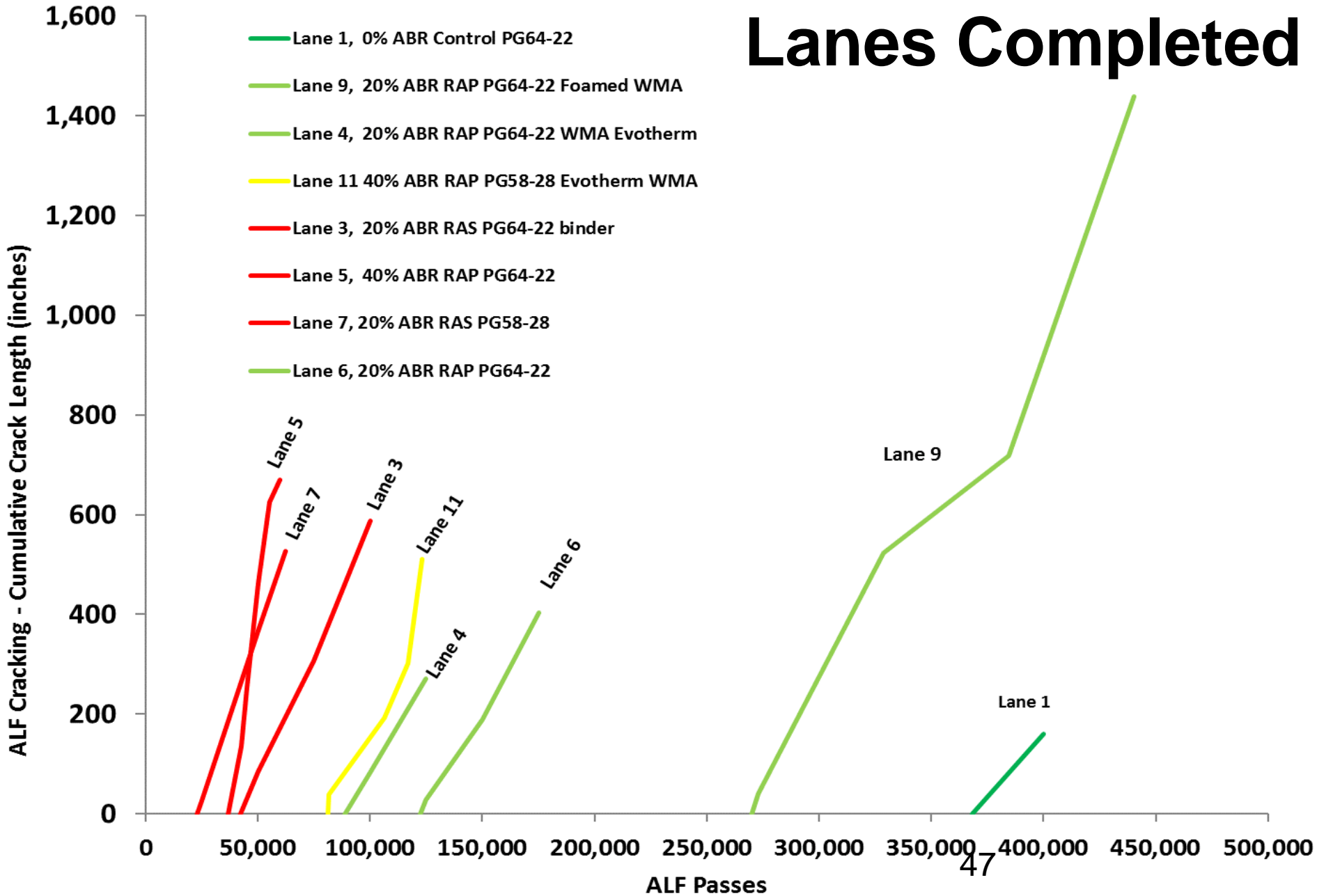
Cracking Measurements

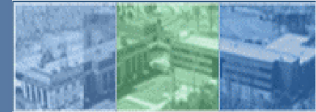


Crack lengths are individually traced with planimeter



Lanes Completed



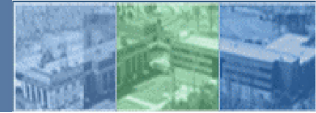


Next Steps

- Complete testing on Lanes 8 and 2
- Complete LVECD analyzes
- Data analysis
 - Data library
 - Data processing
- Post-mortem evaluations
- Reporting and Documentation

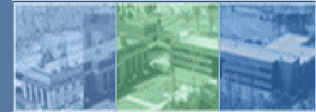
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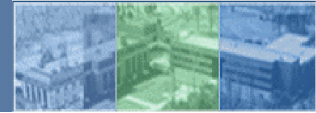
Next Experiment

**ASPHALT CONCRETE FIELD DENSITY
AND AGGREGATE BASE
GEOSYNTHETIC REINFORCEMENT**



Purpose

- The compaction of asphalt concrete (AC) mixtures is a critical component in the process of achieving optimal pavement performance.
- The quality and strength of the substructure (base and subgrade) have great influence of pavement performance.



Objectives

- Investigation of Asphalt Concrete Compaction and Its Impact on Performance of Pavements Built with and without Geosynthetic Base Reinforcement



The Experiment

- One AC mixture
- Three Lanes (3 different AC compaction levels)
 - High (~ 94% compaction)
 - Medium (~ 91%)
 - Low (~ 87%)
- Two structures per lane
 - Unreinforced
 - Reinforced with a Standard BS-1200
- Performance measures
 - Cracking
 - Rutting



ALF Construction

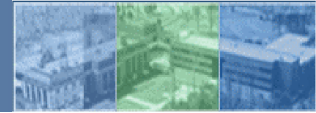
- Aggregate base is being placed
- HMA will be paved in few days





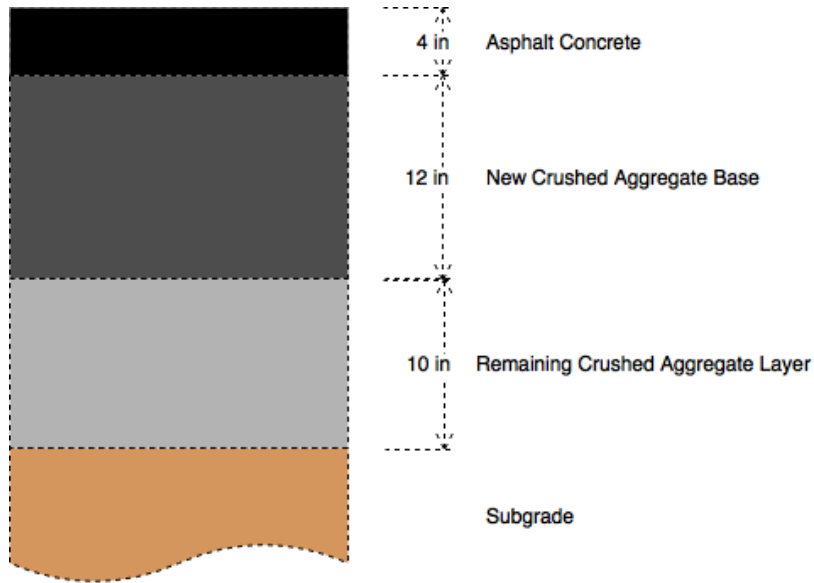
- **FWD testing on aggregate base**
- **Base course reinforcement interaction**
 - **Geogrid reinforcement**
 - **Pressure gauge**



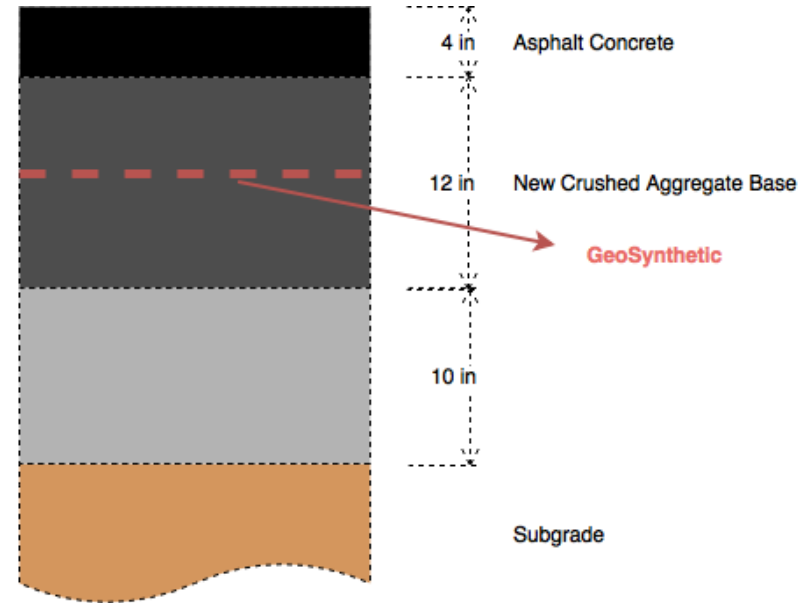


Pavement Structure

No Reinforcement



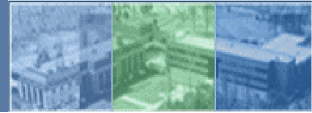
With Reinforcement





Current Status

- Experiment under construction
- Paving expected on or about 9/13/16
- Loading expected to begin late Fall/2016



Any Questions?

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