

Surface Aggregate Classification of Reclaimed Asphalt Pavement (RAP)



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Presentation outline



- Introduction
- Skid resistance and SAC system
- Dynamic friction test (DFT) for measuring aggregate friction
- RAP DFT measurement and its impact on mix slab friction
- Preliminary DFT-based SAC for RAP
- Pilot implementation project: latest status

Introduction

- Skid resistance of asphalt pavement is critical for safety.



- TxDOT has a goal of cutting fatal crashes in half by 2035 and zero fatalities by 2050.

Introduction

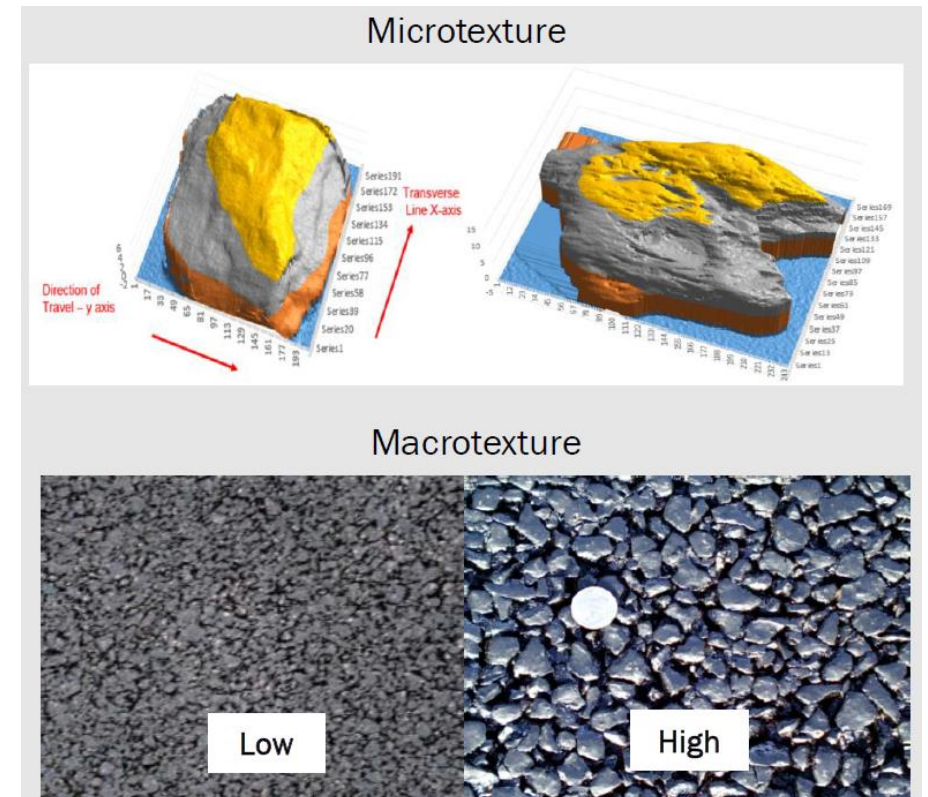
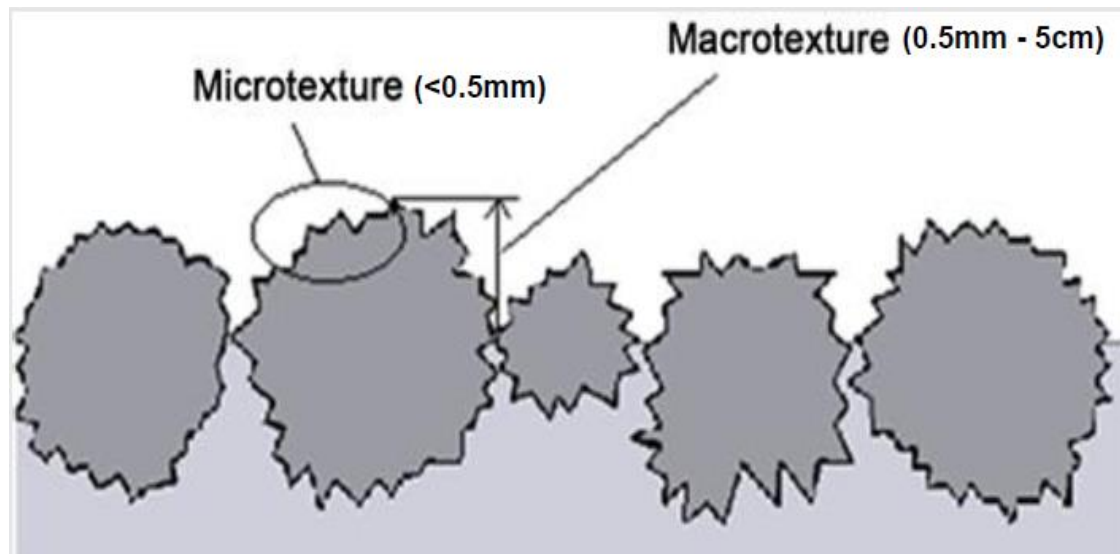
- Demand for SAC-A aggregates significantly increases year after year.
- Both TxDOT and asphalt industry advocate for sustainability.
 - ▣ **RAP** = asphalt binder + aggregates



- The research objective was to investigate if RAP with SAC-A aggregates can be used as SAC-A rather than SAC-B.

Skid resistance and SAC system

- Skid resistance is a function of Microtexture and Macrotexture.
 - ▣ Aggregate type: *Microtexture*
 - ▣ Mix type: Macrotexture



Skid resistance and SAC system

- Current SAC system:

- ▣ Indirect measurement of aggregate texture

Property	Test Method	SAC A	SAC B	SAC C
Acid Insoluble Residue, % Minimum	Tex-612-J	55	---	---

Acid Insoluble Residue



Skid resistance and SAC system

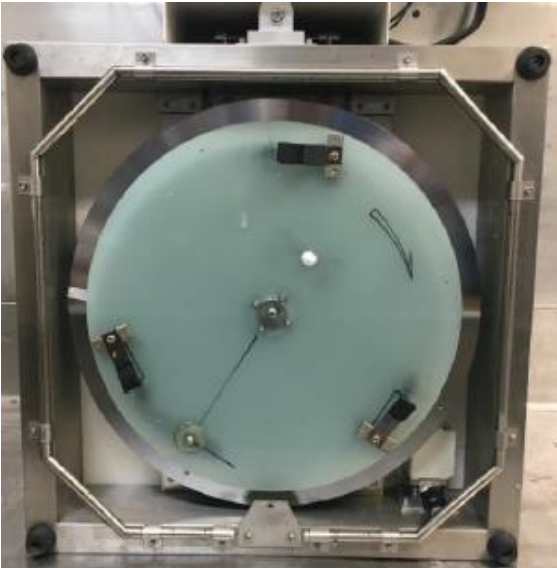
- One SP-D mix with 100% SAC-A aggregates

Class (A) Rock (Y/N):		Yes	Yes	Yes	No		
Sieve Size:		Individual Ret., %	Individual Ret., %	Individual Ret., %	Individual Ret., %	Individual Ret., %	Individual Ret., %
Passing	Retained						
-	3/4"	0.0	0.0	0.0	0.0		
3/4"	1/2"	0.0	0.0	0.0	0.0		
1/2"	3/8"	4.8	0.0	0.0	0.0		
3/8"	No. 4	28.1	6.5	1.4	0.0		
No. 4	No. 8	12.4	2.7	7.3	0.0		
No. 8	No. 30	3.3	0.5	12.7	0.0		
No. 30	No. 50	0.3	0.0	2.8	0.0		
No. 50	No. 200	0.4	0.1	2.8	8.3		
No. 200	Pan	0.9	0.2	3.1	1.7		
Total:		50.0	10.0	30.0	10.0		
Percent of plus No. 4		32.9	6.5	1.4	0.0		
Percent of plus No. 8:		45.2	9.2	8.6	0.0		
Percent of plus No. 4 from class (A) Rock:		40.7				Percent of plus No. 8 from class (A) Rock: 63.1	
Total Percent of plus No. 4		40.7				Total Percent of plus No. 8: 63.1	
Percent of plus No. 4 from class (A) Rock:		100.0				Percent of plus No. 8 from class (A) Rock: 100.0	

Fiscal Year	Skid Number	Skid Test Date
2016	32.0	7/18/2016
2016	30.0	7/18/2016
2016	28.0	7/18/2016
2016	27.0	7/18/2016
2016	30.0	7/18/2016
2016	35.0	7/18/2016
2016	33.0	7/18/2016
2016	36.0	7/18/2016
2016	38.0	7/18/2016
2018	20.6	6/20/2018
2018	19.4	6/20/2018
2018	19.6	6/20/2018
2018	19.6	6/20/2018
2018	24.4	6/20/2018
2018	21.6	6/20/2018
2018	34.7	6/21/2018
2018	38.0	6/21/2018
2018	36.1	6/21/2018

DFT for measuring aggregate friction

- Dynamic friction test (DFT): **direct** measurement
 - ▣ Measures a friction value on wet pavement surface (ASTM E1911)
 - ▣ Spinning disk with 3 rubber sliders contacting surface as disk rotates.



DFT for measuring aggregate friction

□ TxDOT DFT test

- Micro-Deval polishing aggregates: 10,500 revolutions for 1-3/4 hours
- Prepare an aggregate ring: passing 3/8" sieve and retaining on 1/4" sieve
- Run DFT to measure aggregate frictional property: DFT value

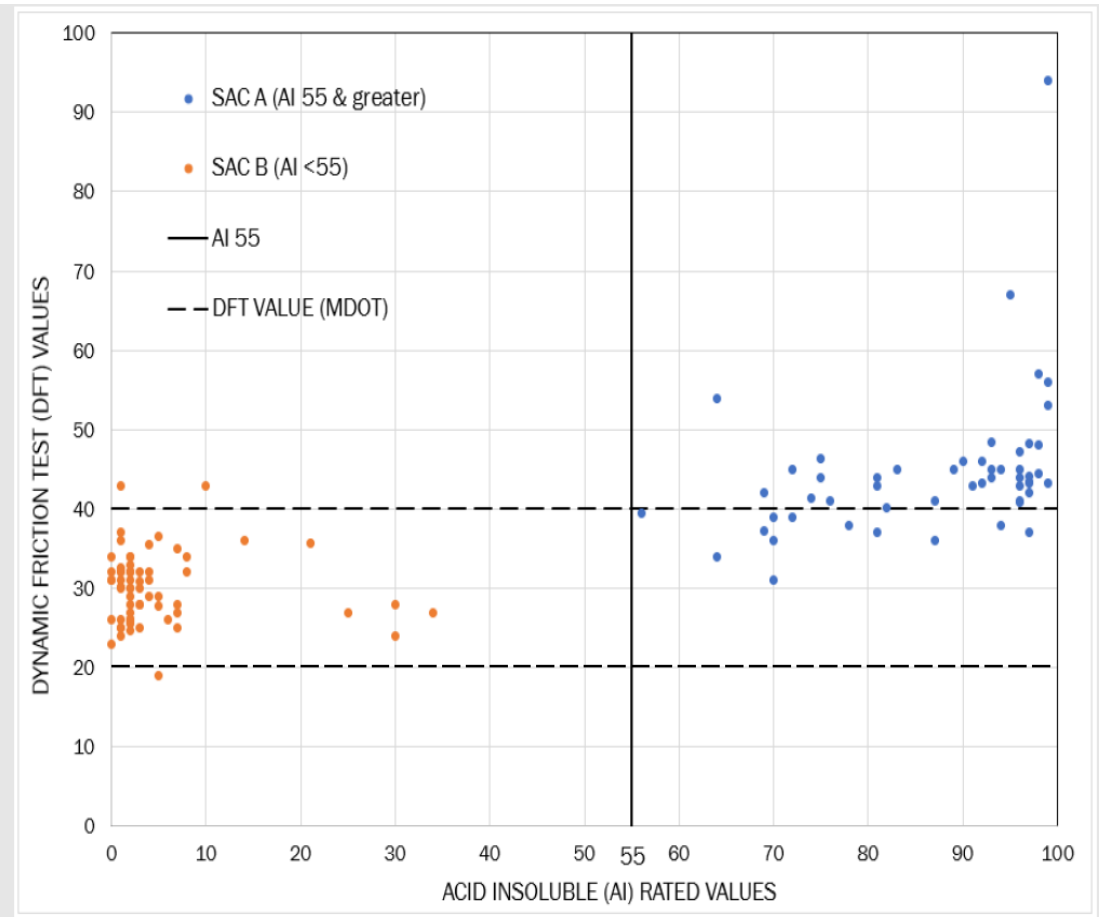


DFT for measuring aggregate friction

Richard Izzo

2020 TxDOT short course

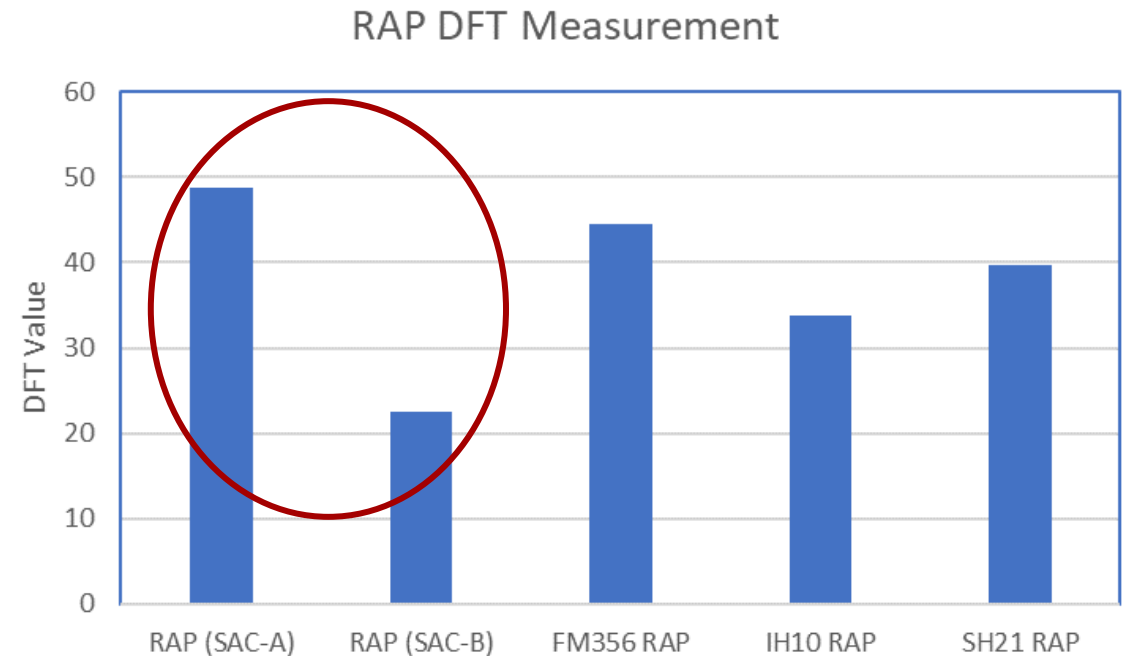
- DFT value compared with acid insoluble for SAC A and SAC B sources.
- All material codes combined - Dolomite, Gravel, Igneous, Lightweight, Limestone, and Sandstone.
- Generally, a high AI > 55 will produce a higher DFT Value.
- DFT does a good job differentiating aggregate sources with lower AI values.



RAP DFT and its impact on mix slab DFT

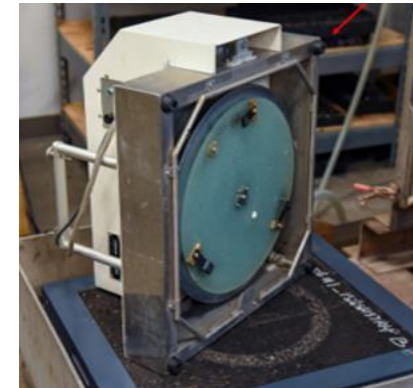
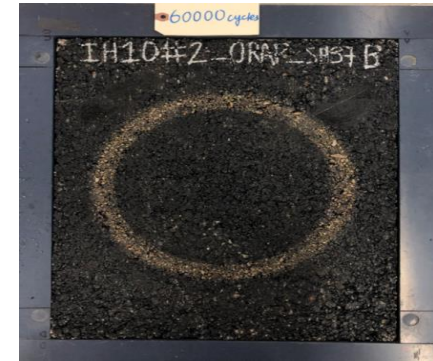
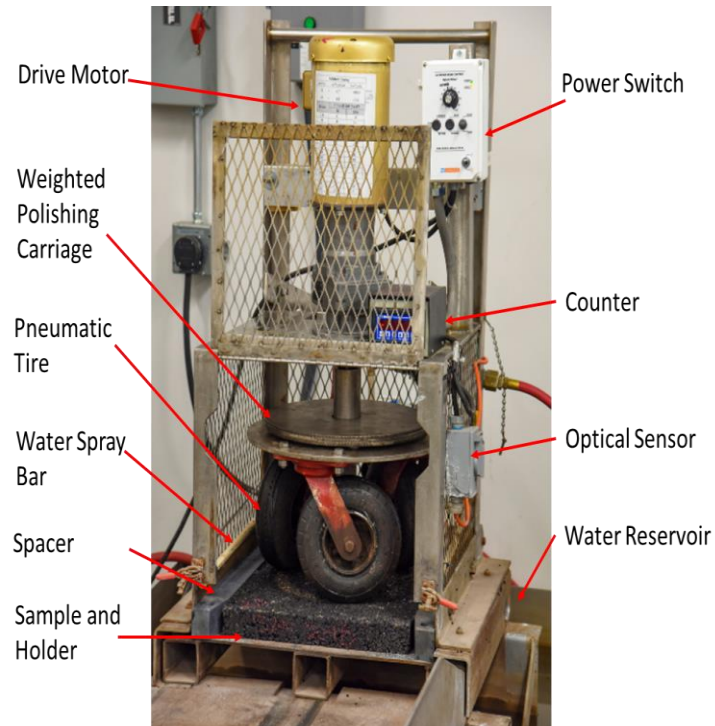
□ RAP DFT

- Ignition oven test
- Micro-Deval polishing aggregates: 10,500 revolutions for 105 min.
- Prepare an aggregate ring: passing 3/8" sieve and retaining on 1/4" sieve
- Run DFT to measure aggregate frictional property



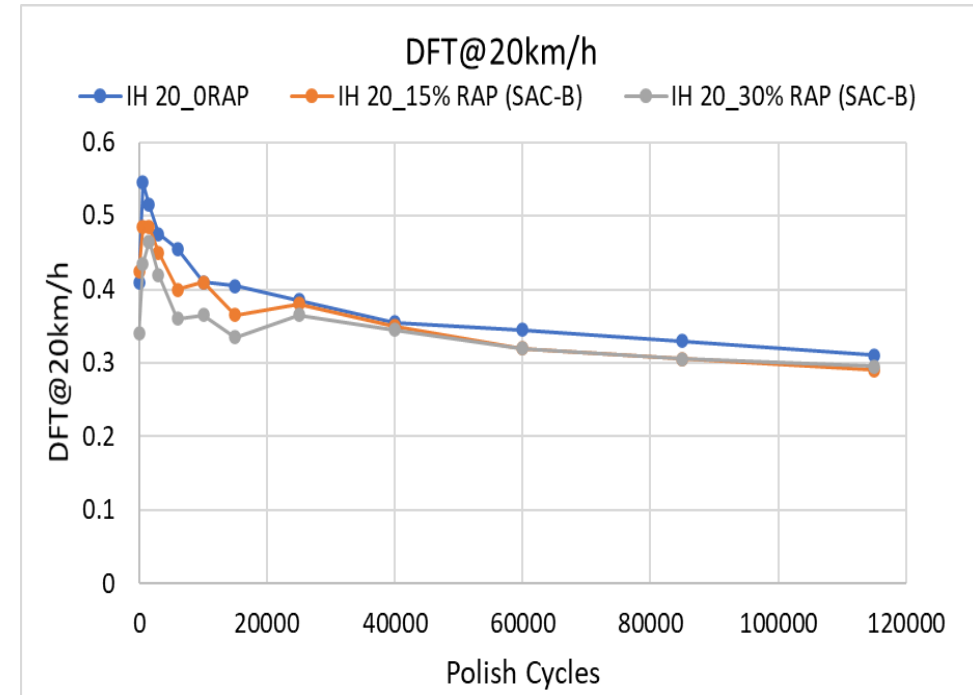
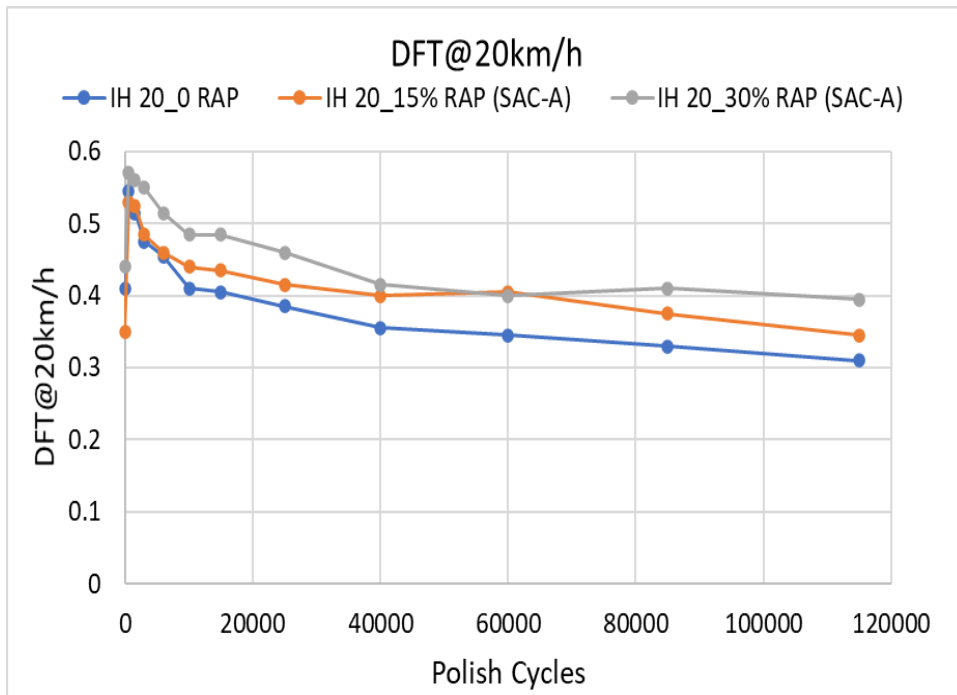
RAP DFT and its impact on mix slab DFT

□ RAP impact on mix slab DFT



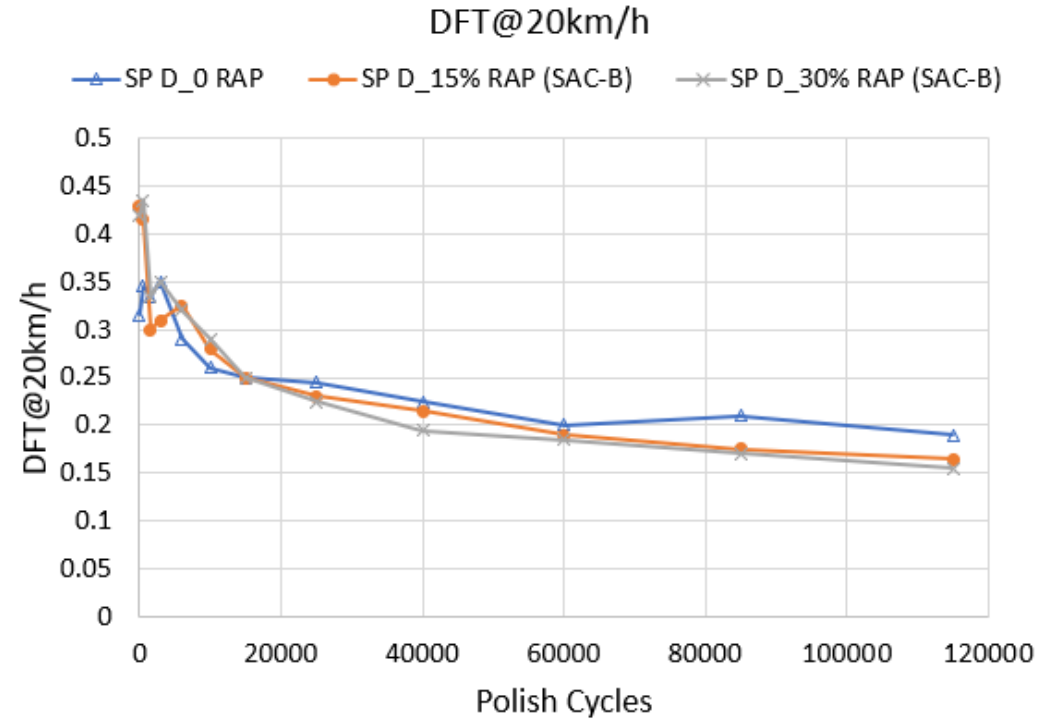
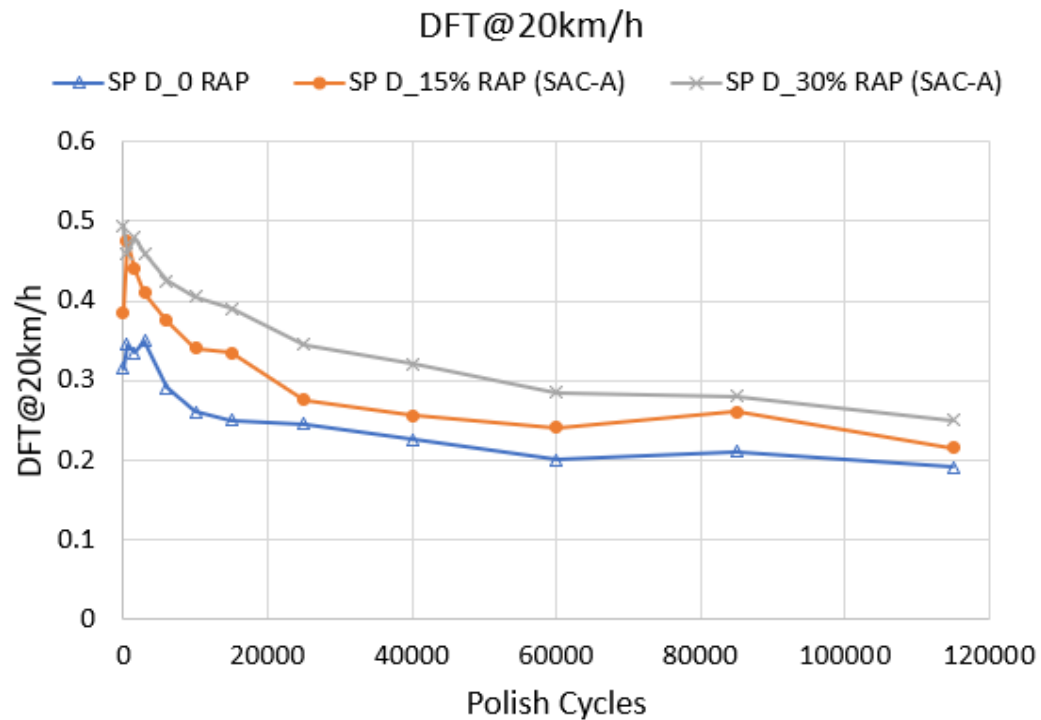
RAP DFT and its impact on mix slab DFT

- RAP impact on mix slab DFT: **one curve=one week**



RAP DFT and its impact on mix slab DFT

- RAP impact on mix slab DFT: one curve=one week



Preliminary DFT-based SAC for RAP

- 20 mixes (40 slabs=8 months' testing)
- SN is a function of mixture microtexture (DFT) and macrotexture (measured by circular track meter-CTM in mean profile depth-MPD)

Mixture Name	Slab DFT * 100 (@ 3000 Cycles)	Blended DFT * 100 (AMD, +#4)	Macro-MPD, mm	IFI	SN (50)
FM 356_0 RAP	49	41.8	0.748	0.261	26.3
FM 356_15% RAP (SAC-A)	52	42.8	0.661	0.278	28.4
FM 356_30% RAP (SAC-A)	50.5	42.8	0.641	0.270	27.3
FM 356_15% RAP (SAC-B)	46.5	40.7	0.865	0.247	24.7
FM 356_30% RAP (SAC-B)	45	38.5	0.537	0.239	23.7
IH 20_0 RAP	47.5	32	0.682	0.253	25.3
IH 20_15% RAP (SAC-A)	48.5	33.5	0.730	0.259	26.0
IH 20_30% RAP (SAC-A)	55	35.1	0.694	0.296	30.5
IH 20_15% RAP (SAC-B)	45	31.2	0.473	0.239	23.7
IH 20_30% RAP (SAC-B)	42	30.4	0.408	0.223	21.8
IH 10_0 RAP	26	29.3	0.513	0.147	13.2
IH 10_15% RAP (SAC-A)	31	31.1	0.500	0.169	15.6
IH 10_30% RAP (SAC-A)	38	32.2	0.460	0.202	19.4
IH 10_15% RAP (SAC-B)	25.5	29.3	0.772	0.144	12.9
IH 10_30% RAP (SAC-B)	22.5	28.7	0.473	0.132	11.7
SP D_0 RAP	35	33.4	0.775	0.188	17.7
SP D_15% RAP (SAC-A)	41	34.2	0.653	0.218	21.2
SP D_30% RAP (SAC-A)	46	35.7	0.657	0.245	24.3
SP D_15% RAP (SAC-B)	31	31.8	0.462	0.169	15.6
SP D_30% RAP (SAC-B)	35	31	0.460	0.188	17.7

Preliminary DFT-based SAC for RAP

- Preliminary recommendation

Property	Test Method	SAC-A for RAP
<i>Micro-Deval loss, % max (TxDOT 0-6959)</i>	<i>Tex-461-A</i>	<i>15</i>
<i>DFT *100 (After Micro-Deval), min</i>	<i>ASTM E1911 TxDOT aggregate ring</i>	<i>43</i>

Pilot implementation project 5-7025-01

- Select 3 field projects with milled RAP
- Evaluate RAPs using both SAC aggregate tests and DFT
- Design the mixes using the SAC-A RAPs
- Construct field test sections with the SAC-A RAPs
- Monitor and measure field skid number and DFT friction
- Verify and adjust the preliminary SAC-A RAP criteria
- Training workshops

Pilot implementation project 5-7025-01

- Identified two field RAP sources



Fort Worth (FW) RAP, Texas Materials
Milled from IH35
Fractionated
Sampled on Feb. 8th, 2024



Waco RAP, Big Creek Materials
Milled from PFC surface
Non-fractionated
Sampled on June 26th, 2024

Pilot implementation project 5-7025-01

- RAP evaluation
 - ▣ Verify if RAP is SAC-A through aggregate test-Acid Insoluble test
 - ▣ Conduct DFT test on RAP aggregates after ignition oven and micro-deval
 - ▣ Check the possibility of directly testing RAP without ignition or extraction
 - DFT test on **raw RAP (without washing)** before micro-deval
 - DFT test on **washed RAP** before micro-deval
 - DFT test on RAP **after** micro-deval

Pilot implementation project 5-7025-01

- SAC-A RAP evaluation challenges
 - ▣ RAP is a blended material and its coarse (retained on No. 4 sieve) and fine (passing No. 4 sieve) portions may differ significantly.
 - ▣ Aggregate ring DFT requires size passing 3/8" and retained on 1/4" (coarse portion only).
 - ▣ Acid insoluble test requires size passing No. 4 sieve and retained on No. 8 sieve (fine portion only).

Pilot implementation project 5-7025-01

□ RAP evaluation

- ▣ Verify if RAP is SAC-A through aggregate test-Acid Insoluble test

Aggregate Size	Sample No.	Ignition Oven	Auto Extraction
Passing No. 4, retaining on No. 8	1	35	41
	2	38	36
	3	36	38
	Average	36	38
Passing 3/8", retaining on No. 4	1	53	37

Pilot implementation project 5-7025-01

□ RAP evaluation

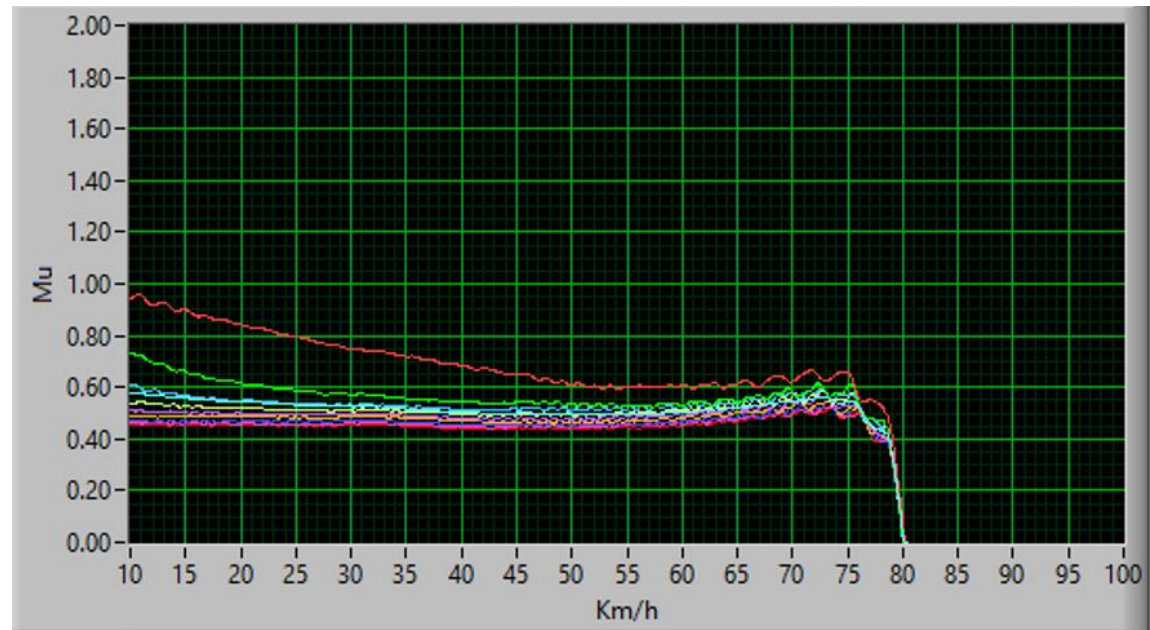
- Conduct DFT test on RAP aggregates after ignition oven and micro-deval



Pilot implementation project 5-7025-01

- RAP evaluation

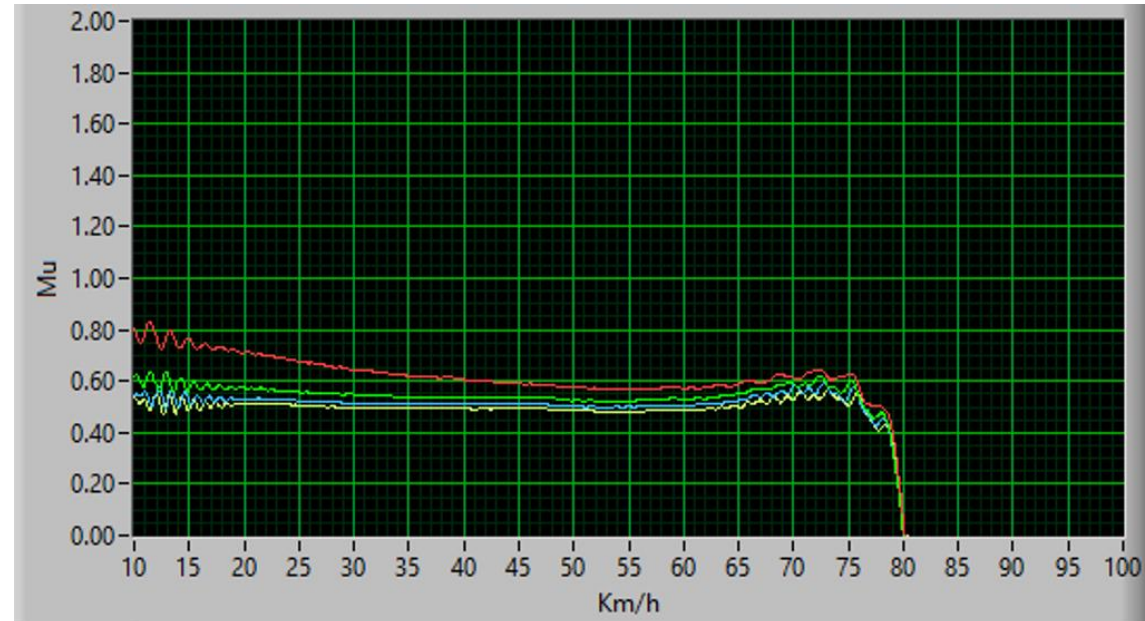
- DFT test on raw RAP (without washing) before micro-deval



Pilot implementation project 5-7025-01

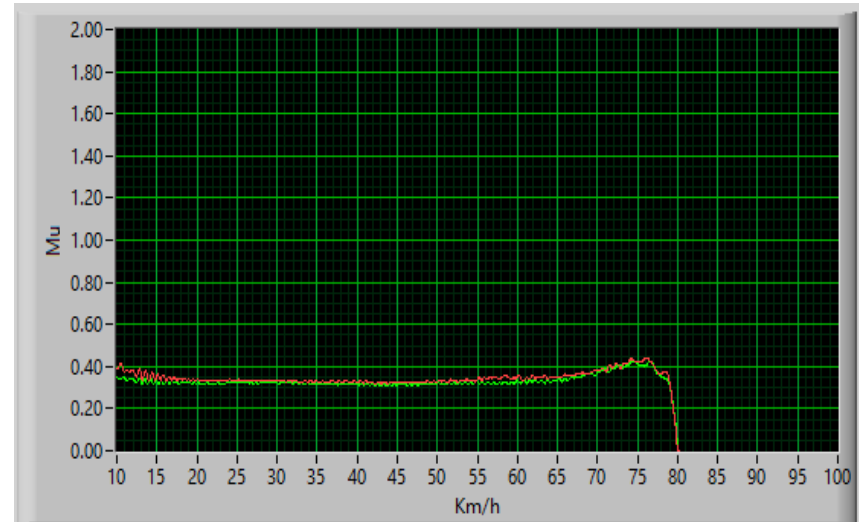
- RAP evaluation

- DFT test on washed RAP before micro-deval



Pilot implementation project 5-7025-01

- RAP evaluation
 - DFT test on RAP after micro-deval



Pilot implementation project 5-7025-01

□ RAP evaluation

▣ DFT test results comparison

DFT @ 20 km/h

	Sample 1	Sample 2	Sample 3	Average
Before ignition, before micro-deval	0.47	0.52	0.56	0.52
Before ignition, after micro-deval	0.33	0.33	0.3	0.32
After ignition, after micro-deval	0.43	0.46	0.47	0.45

DFT @ 60 km/h

	Sample 1	Sample 2	Sample 3	Average
Before ignition, before micro-deval	0.45	0.5	0.53	0.49
Before ignition, after micro-deval	0.34	0.31	0.3	0.32
After ignition, after micro-deval	0.42	0.43	0.44	0.43

Pilot implementation project 5-7025-01

- RAP evaluation

- ▣ Sent 3 buckets of Waco PFC RAP to MTD for further testing



Pilot implementation project 5-7025-01

- Field test sections with SAC-A RAP
 - Fort Worth District: new letting in Jan. 2025.
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Q/A

Thank You All!