

5th Asphalt Shingles Recycling Forum

State of Practice in Texas: RAS Process, Management, Variability, Binder Characterization and Mix Design Considerations

TxDOT Research Project 0-6614

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TxDOT Study 6614

Year 1

- ▶ RAS process and management
- ▶ RAS variability and Binder characterization
- ▶ Do existing stockpiles meet TxDOT requirements

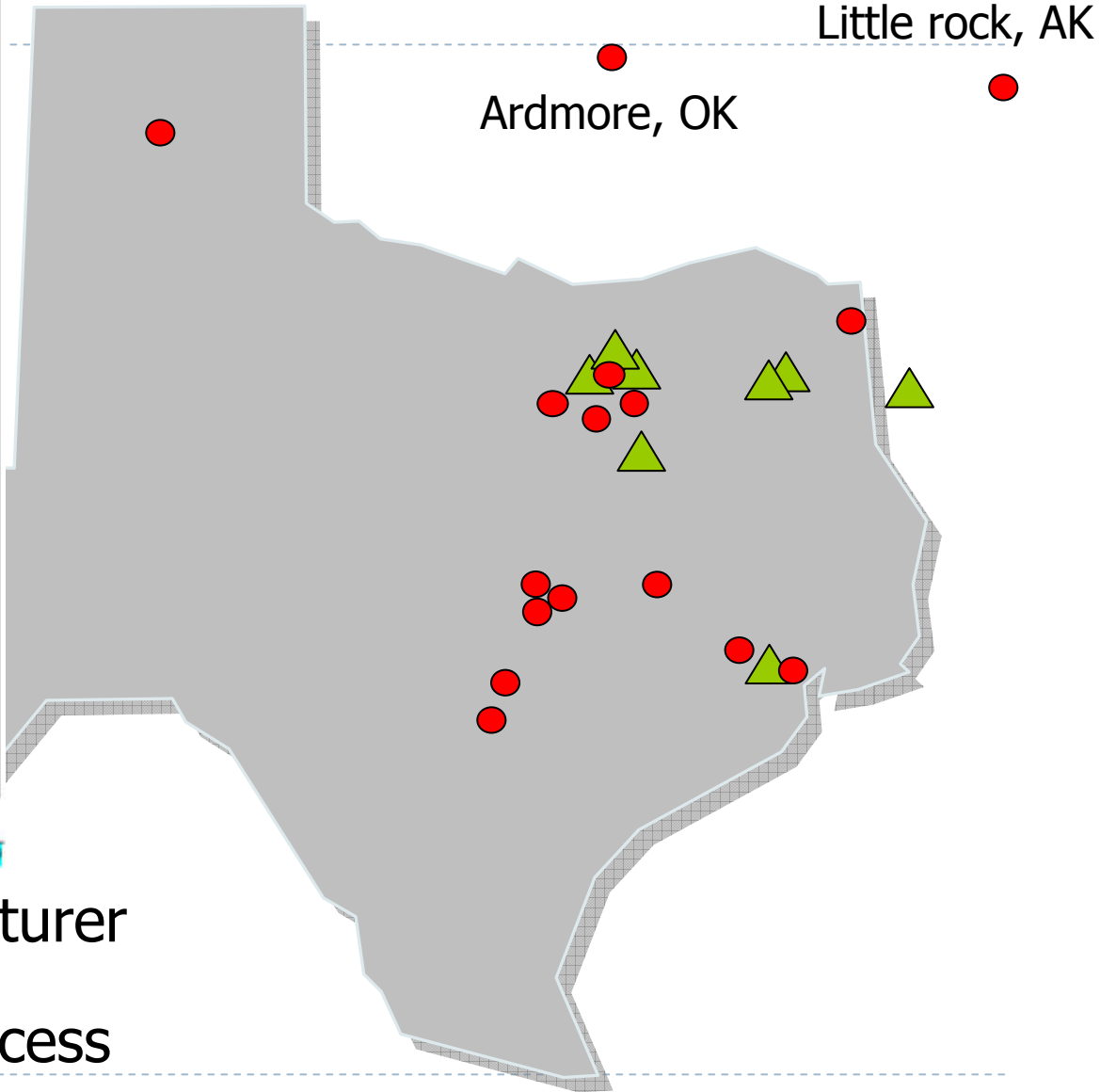
Year 2 Mix Design and Construct Field test sections

- ▶ Balanced RAS mix design



20+ RAS Processors

Pre-Qualified Producers of Non-Hazardous Recycled Materials			
Producer	Contact Info	Recycled Material	Primary Applications
APAC-Texas, Inc. Sunnyvale Plant 4601 E. Scyene Rd. Sunnyvale, TX 75182	David Morton (214) 926-9116	Shingles (Pre-consumer)	Asphalt Concrete
APAC-Texas, Inc. Leston Plant Leston Ave. Dallas, TX 75247	David Morton (214) 926-9116	Shingles (Pre-consumer)	Asphalt Concrete
APAC-Texas, Inc. Cold Springs Plant 1901 Cold Springs Rd. Ft. Worth, TX 76101	David Morton (214) 926-9116	Shingles (Pre-consumer)	Asphalt Concrete
R. K. Hall Construction 7474 South Staline Texarkana, TX 75501	Brad Bankston (903) 715-2784	Shingles (Pre-consumer)	Asphalt Concrete
Ramming Paving Company LTD 5307 Highway 195 Georgetown, TX 78628	Lance Townsend (512) 750-4479	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Ramming Paving Company LTD 1101 FM 2770 Buda, TX 78610	Lance Townsend (512) 750-4479	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Sustainable Pavement Technologies, LLC 1605 Genoa Red Bluff Rd Pasadena, TX 77504	Jeff Wanic (979) 236-5888	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Recon Recycle 6005 FM 973 South Del Valle, TX 78617	Mark Schmitt (512) 894-4441	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Waste Management WMAF Shingle Recycling Unit 600 Landfill Rd. Hutto, TX 78634	Josh Broussard (512) 539-8193	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Century Asphalt, Ltd. Melendy Plant 11913 FM 529 Houston, TX 77041	D. Nick Anders (713) 923-7250	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete



- ▲ Shingle Manufacturer
- Capability to process asphalt shingles

RAS: Process, Management, Variability, & Binder Characterization

▶ Year I Work Plan:

- ▶ Visit RAS processors including contractors and independent recyclers (processors) (DOCUMENT Best Practices)
- ▶ Sample processed RAS materials (7 processors)
- ▶ Conducted laboratory tests
 - ▶ Dry sieve analysis
 - ▶ Ignition oven test
 - ▶ RAS binder extraction and recovery tests
- ▶ Determined RAS variability: gradation and asphalt content
- ▶ Began RAS binder characterization



RAS Processing

Step 1: Sorting



Step 2: Grinding



Step 3: Screening



This step can give you whatever size you need for better mix.

Step 4: Stockpiling



Ignition Oven Test and Results

- Gradation
- Asphalt Content (AC)



Wet Sieve Analysis Results after Ignition Test

Shingle B-Manufacture waste

Sieve size	#1	#2	#3	#4	#5	#6	#7	Average	Standard deviation
1/2"	100	100	100	100	100	100	100	100	0.0
3/8"	100	100	100	100	100	100	100	100	0.0
#4	100	100	100	100	99	98	99	99	0.5
#8	99	98	99	99	98	95	97	98	1.5
#16	85	83	85	86	83	80	83	83	2.0
#30	66	63	64	65	63	59	61	63	2.1
#50	57	53	54	55	52	50	51	53	2.3
#100	45	42	42	43	37	37	37	40	3.1
#200	33	30	30	32	27	27	28	30	2.2
AC	21	19	21	19	20	20	19	20	0.7



Wet Sieve Analysis Results after Ignition Test

Shingle G Tear Offs

Sieve size	#1	#2	#3	#4	#5	#6	#7	Average	Standard deviation
1/2"	100	100	100	100	100	100	100	100	0.0
3/8"	100	100	100	100	100	100	100	100	0.0
#4	99	99	99	99	99	99	99	97	1.5
#8	96	97	97	97	97	97	98	94	2.5
#16	72	79	80	71	75	76	74	75	3.1
#30	52	58	50	54	54	54	55	54	2.6
#50	45	52	52	44	47	49	49	48	2.7
#100	36	44	44	37	40	41	41	40	2.7
#200	25	33	32	27	29	30	31	30	2.4
AC	22	24	22	23	23	23	24	24	0.7



Asphalt Binder Extraction and Recovery Test and Results

- Gradation
- Asphalt Content (AC)
- RAS Binder PG Grade



Comparison between Ignition and Extraction

Sieve size	Shingle B-manufacture waste		Shingle C-manufacture waste		Shingle E-Tear-off (3 replicates)	
	Ignition	Extraction	Ignition	Extraction	Ignition	Extraction
1/2"	100	100	100	100	100	98
3/8"	100	100	100	100	100	97
#4	99	98	99	97	96	94
#8	98	97	98	96	92	92
#16	83	83	81	81	72	74
#30	63	63	62	63	50	52
#50	53	54	56	57	44	46
#100	40	41	47	47	37	39
#200	30	29	36	36	27	28
AC	20	20	22	21	26	23



Summary

- ▶ All processed RAS met TxDOT gradation requirement of 95% passing 3/8 in sieve
- ▶ Tear Off have higher binder content 23 to 28%, MFW consistent at 20%
- ▶ RAS variability low for both
- ▶ Ignition oven yields slightly higher binder content, but acceptable for binder content and aggregate gradation
- ▶ RAS binders are very stiff – cause for concern in mix design



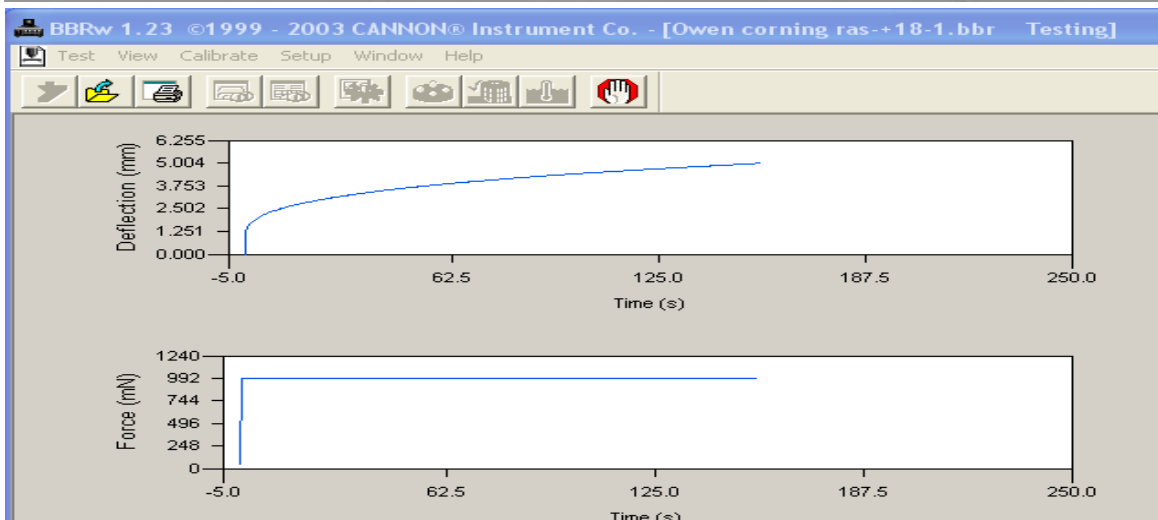
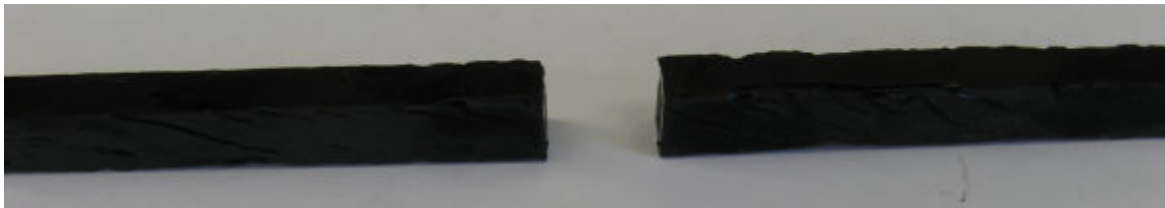
Early Pavement Cracking Concerns



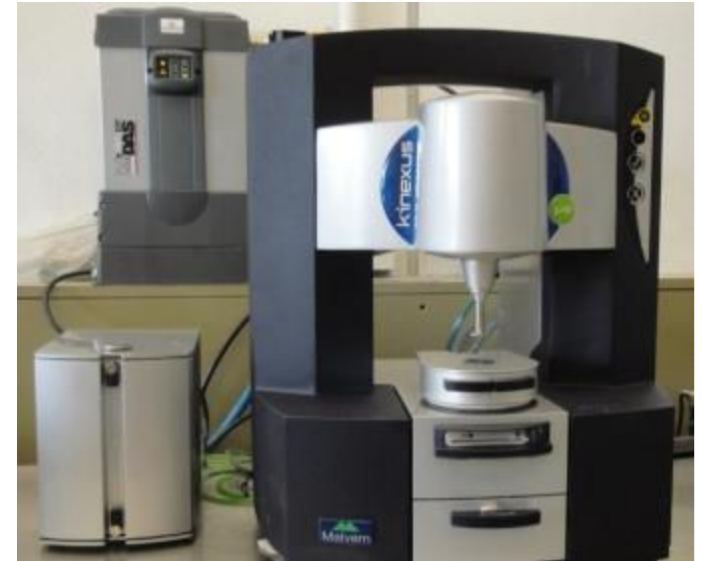
Study 6614 RAS Binder Characterization

Typical Virgin asphalt Binder PG 64 - 22

- ▶ Shingle C-manufacture waste
 - ▶ High temperature PG grade
 - Original: PGI39
 - ▶ Low temperature PG grade
 - PAV: PG+8



High temp. DSR (-10C-200C)



PG Grading of Texas RAS

PG 64-22

High End	Road Temps Average of 7 hottest days expected for site	64C	147F
Low end	Road temps coldest day	-22C	-7F

- ▶ RAS-B (MW) PG 146 + 8 (295 + 46 °F)
- ▶ RAS-C (MW) PG 134 + 2
- ▶ RAS-E (TO) PG 164 + 18
- ▶ RAS-F (TO) PG 200 + 25 (392 + 77 °F)



Effect of RAS Content on Final PG Grade

Binder	PG Grade	AC %	% in Mix
PG 64-22	67	5.2 (4.0)	
RAS	96	24.0 (1.2)	5.0
RAP	87	5.0	
	73.7	Combined Grade	



Summary Recommendations (R Williammee, TxDOT Fort Worth)

Ways to mitigate RAP/RAS concerns:

- increase the target lab density to get more total asphalt binder into the mix
- start with a lower base asphalt grade to lessen cracking
- utilize a crack measurement test such as the Overlay Tester to establish an objective cracking criteria
- use WMA to improve mixing and compaction

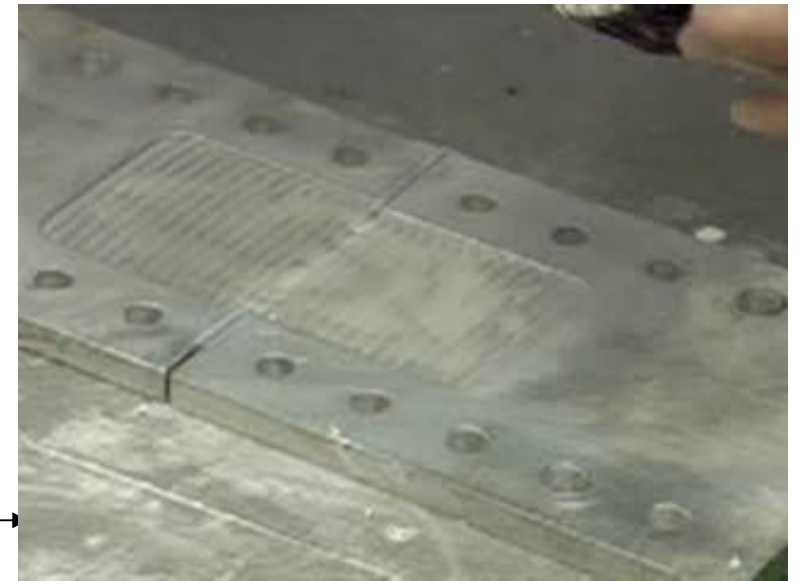
Balanced Mix Design Concepts

Meeting Rutting and Cracking Requirements

- Hamburg Wheel Tracking test



- Overlay Tester



< 12.5 rut after 20,000 passes

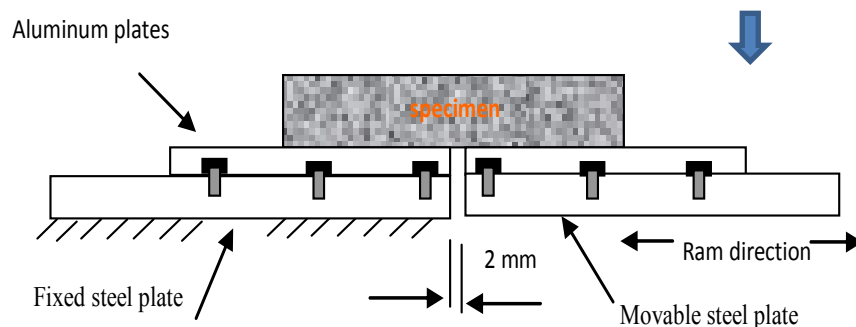
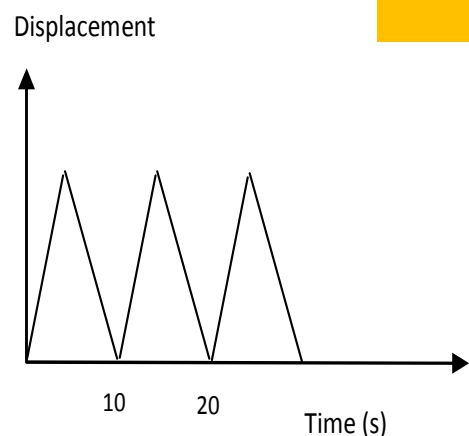
Minimum number of cycles to cracking failure

The Overlay Tester (OT)



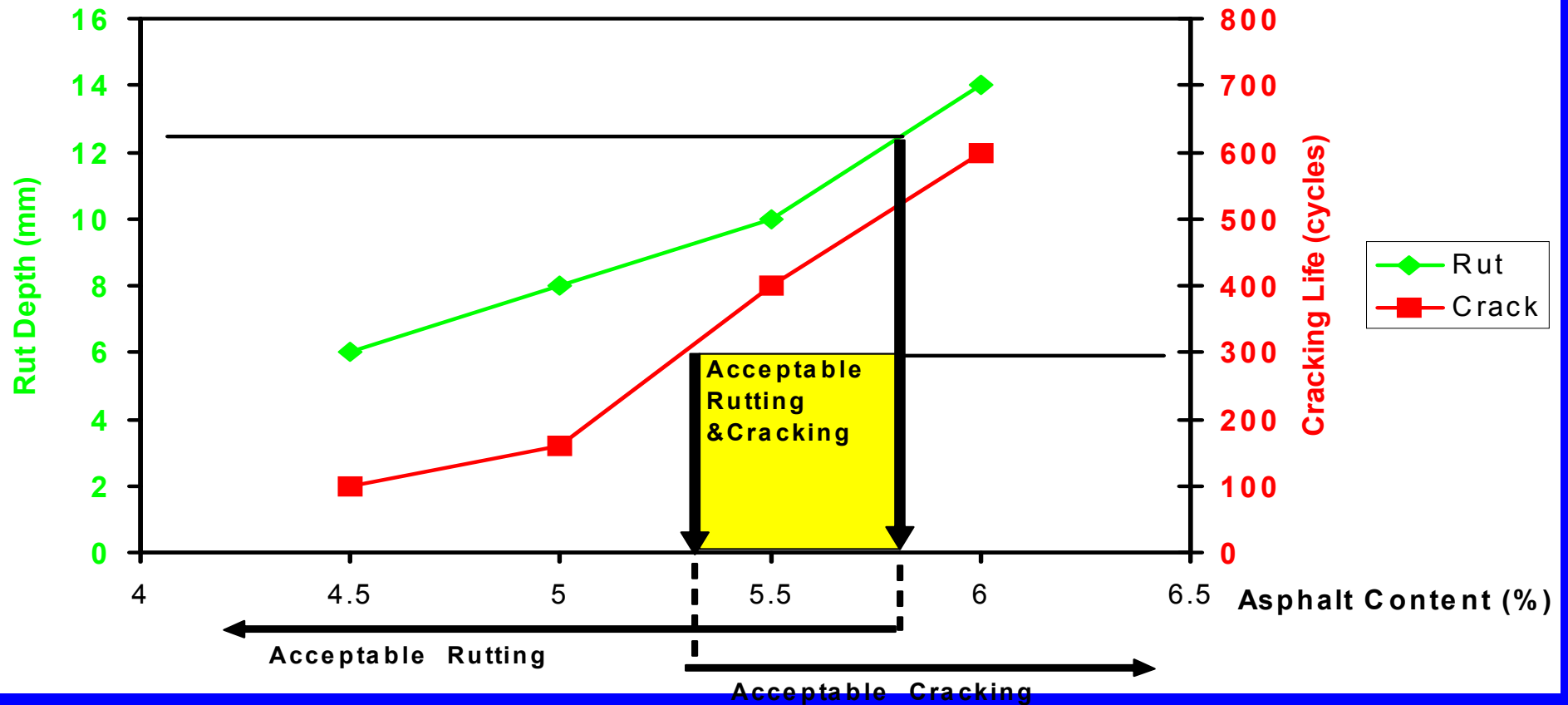
Measures load, number of cycles, time, etc

- Overlay Tester (OT)
- Room temp 25 C 0.025 inch (0.635 mm)
- 10 s/cycle
- In Texas OT $\geq 300, 750,$ @ 93%



Balanced Mix Design Concept

Balancing Rutting and Cracking



Most Performance Mixes Pass with ease

Impact of RAP and RAS on Lab Tests

Type D Mix Paris District

Challenges

RAP %	RAS %	Hamburg Test (< 12.5 mm)	Overlay Test	IDT (> 200 psi)
0	0	4.3	123	145
15	0	3.9	70	155
0	5	3.0	20	141
15	5	1.5	5	214

Opportunities

Add binder
Change Binder

Binder	\$ Ton
64-22	575
70-22	684
76-22	727
64-28	684

Work underway with softer binders especially xx-28 and xx-34
Overlay Tester results from MnRoad Mixes encouraging

We Are Looking for RAS Field Test Sections

We'd like to work with any districts, contractors, recyclers
to better use RAS in asphalt mixes.

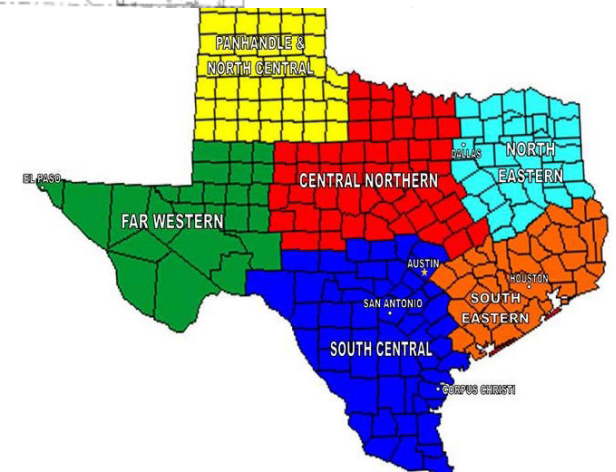
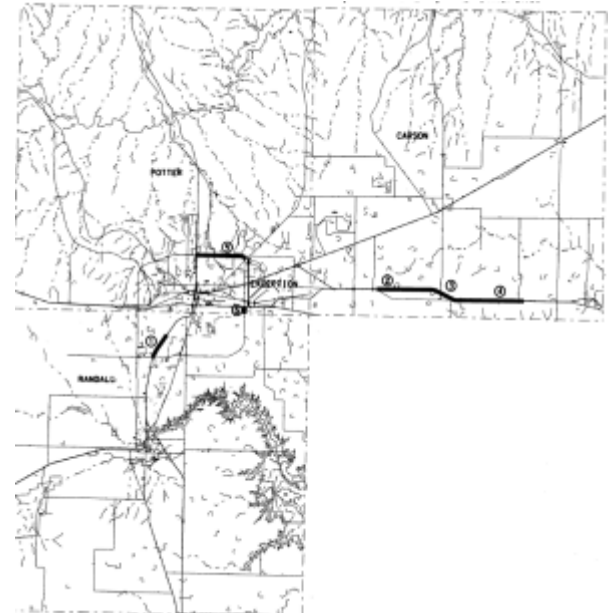
Contact Robert Lee
Fujie Zhou

Amarillo RAP test sections

RAP improves rutting test results makes cracking results worse

Experimental test sections on IH40:

- 0% RAP section: Control section
- 20% RAP section: TTI designed**
- 35% RAP section: TTI designed**



Summary of RAP mix design

Section	RAP (%)	Virgin binder	Designer	Mix design approach	AC (%)	Hamburg rut depth @20000	OT cycles
0	20	PG64-28	Contractor	Item 340-Type C	5.0	3.72	10
1	0	PG64-28	Contractor	Item 340-Type C	4.8	4.38	50
2	35	AC-10 (PG58-28)	TTI	Balanced mix design	5.5	8 mm	200
3	20	PG64-28	TTI	Balanced mix design	5.3	7.4 mm	125

IH 40 RAP Test sections

Summer 2009

Type C Texas Gyrotory Design
Fractionated RAP



September 8, 2010



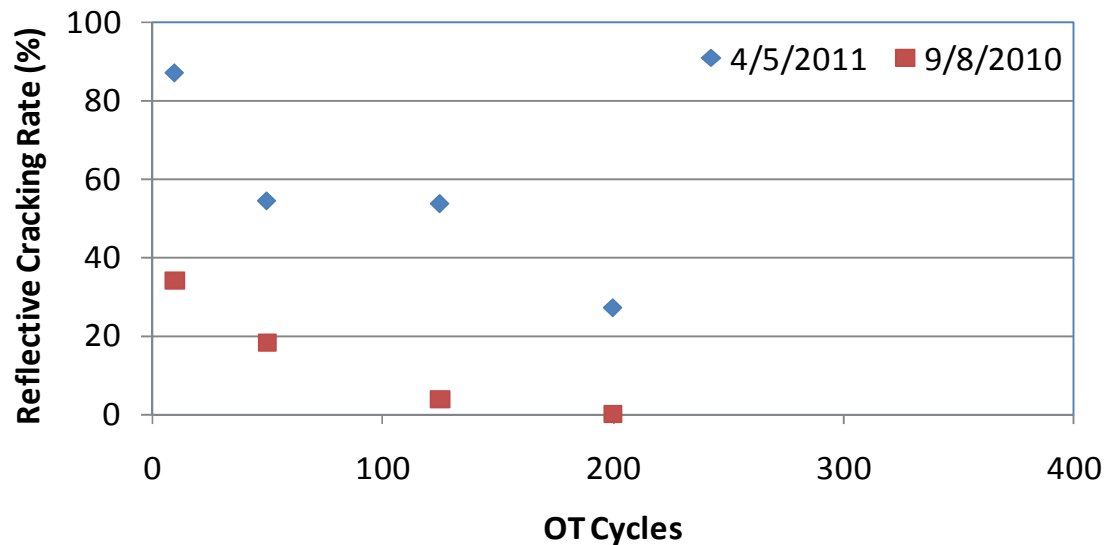
April 5, 2011



Reflection Cracking Rate (%) (reflected/total existing cracks)

Sections	8/11/2009	4/22/2010	9/8/2010	4/5/2011	OT cycles
20% RAP-contractor	0	0	34	87	10
0% RAP-contractor	0	0	18	55	50
35% RAP-TTI	0	0	0	27	200
20% RAP-TTI	0	0	4	54	125

IH40 RAP Sections: OT vs. Reflective Cracking



Another validation of 300 cycles

