

TxDOT Experience With Warm Mix Asphalt & RAP



Alaska Asphalt Paving Summit

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Warm Mix Benefits

- More Durable Pavement
 - Less oxidized + less absorption = better fatigue life
- Better in-place densities
 - Improved fatigue life
 - better bonus for contractor
 - SMA 2.5% increase in bonus for 1% increase in density
- Wider Paving Window
 - Winter Paving
 - Night Paving
- Reduced Emissions, Smoke & Odor
- Direct Energy Savings ~ \$1/ton

Initial Thoughts

- Before we save the planet, let's make sure it meets our specifications.
- Let's make sure it's not detrimental to our roads.
- We can try it, but what's the benefit to TxDOT?



Challenges

- Extra Cost (who is going to pay for it?)
 - Allow or Require
- Generic Specification Development
- Mix Design Impacts
- Unfamiliarity
- Hamburg Wheel Test Requirement
- Long Term Performance

Current Status

- WMA is allowed for use at Contractor's option on most HMA projects
- A few districts require WMA by plan note
 - Environmental reasons – non attainment areas
 - Overlays on pavements with rubber crack seal
- Most Contract's have or are in the process of installing a WMA additive system



Warm Mix Asphalt (WMA) is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. WMA is allowed for use at the Contractor's option unless otherwise shown on the plans. The use of WMA is required when shown on plans. When WMA is required by the plans, produce an asphalt mixture within the temperature range of 215°F and 275°F. When WMA is not required as shown on plans, produce an asphalt mixture within the temperature range of 215°F and 350°F. Unless otherwise directed, use only WMA additives or processes listed on the Department's approved list maintained by the Construction Division.

Article 341.4. Construction, Section E. Production Operations, Section 2. Mixing and Discharge of Materials is supplemented with the following:

When WMA is specified on the plans, produce the mixture and monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 275°F or is less than 215°F. When WMA is specified, the Department will not pay for or allow placement of any WMA produced at more than 275°F or less than 215°F, unless otherwise directed.

Where We Are Now

- TxDOT has completed 30+ WMA projects to date, 15 are being constructed, and 12 more are let but not yet constructed
- 2 Districts using WMA as maintenance mix
- Approx. 693,700 tons of WMA completed in 15 Districts
- 2009 – 563,200 tons of WMA under construction and another 173,510+ tons under contract pending construction.
- Interstate, US Highways, State Highways and FM roadways
- Numerous local government and commercial projects.

Projects Overview

District	Roadway	Lift Thickness	Mix Type	Approximate Tonnage	WMA Additive or Process
Amarillo	IH 40*	1.5 to 5 inches	Type D	30,400	
Atlanta	SH 8	2 inches	Type D	5,000	Astec D.B. Green
	FM 3129	4 inches	Type D	2,700	Astec D.B. Green
	IH 30	3 inches	Type C	15,000	Astec D.B. Green
Austin	SH 71	2 inches	Type C	7,000	Evotherm
	IH 35	2 inches	SMA C	16,500	Evotherm
Beaumont	IH 10	1 1/2 inches	SMA C	8,000	Redi-Set WMX
	US 190	2 inches	Type C	40,000	Redi-Set WMX
Bryan	SH 21	2 inches	Type C	7,700	Foaming Process
	IH 45*	2.5 inches	Type C	45,500	Foaming Process
	SH 36*	2 inches	Type C	17,200	Foaming Process
		1.5 inches	Type D	12,900	Foaming Process
	SH 6*		Type C	7,100	
		6 inches	Type B	3,600	

*construction in progress

Projects Overview

District	Roadway	Lift Thickness	Mix Type	Approximate Tonnage	WMA Additive or Process
Corpus Christi	IH 37	2 inches	Type C	46,900	Terex
	US 77	2 inches	Type C	16,800	Foaming Process
El Paso	SH 118	2 inches	CMHB-F	20,000	Terex
	FM 1110	2 inches	Type C	2,300	Evotherm
	LP 375	2 inches	Type C	10,900	Astec D.B. Green
	SPUR 601*	2 inches	Type C	1,000	Astec D.B. Green
	US62/180*	2 inches	Type C	26,000	Foaming Process
Fort Worth	BU 287	3 inches	Type B	53,800	Evotherm
		2 inches	Type D		
	FM 1938	2 inches	Type D	20,000	Evotherm
		8 inches	Type B	22,000	
	FM 156	2 inches	Type D	12,200	Evotherm
		10 inches	Type B		

*construction in progress

Projects Overview

District	Roadway	Lift Thickness	Mix Type	Approximate Tonnage	WMA Additive or Process
Fort Worth	SH 183	2 inches	Type D	20,300	Foaming Process
	FM 1220	2 inches	Type D	-	Control
				21,000	Evotherm
	IH 820*	2 inches	Type D	34,000	Evotherm
	SH 26	2 inches	Type D	3,500	Evotherm
	SH 171	1.5 inches	Type D	3,900	Evotherm
	US 180*	2 inches	Type D	38,400	Evotherm
Houston	FM 2004 / FM 2917*	1.5 inches	Type D	8,600	Evotherm
				-	Control
Lufkin	FM 324	1 inch	Type D	3,800	Advera, Redi-Set, Evotherm & Sasobit
				-	Control
Odessa	FM 761	2 inches	SP-C	6,000	
	SH 115*	3 inches	SP-C	32,500	

*construction in progress

Projects Overview

District	Roadway	Lift Thickness	Mix Type	Approximate Tonnage	WMA Additive or Process
Paris	SH 78		Type B & D	16,600	Astec D.B. Green
	US 82	2 inches	Type D	38,800	Astec D.B. Green
		4 & 6 inches	Type B		
	US 380*		Type B & D	83,300	Astec D.B. Green
	IH 30*	2 inches	Type D	109,500	Astec D.B. Green
6 & 7 inches		Type B			
San Angelo	US 83	2 inches	CMHB-C	83,200	Terex
San Antonio	LP 368	2 inches	Type C	1,200	Evotherm
				-	Control
	IH 37*	2 inches	Type C	20,000	Evotherm & Sasobit
				-	Control
Waco	FM 2113	2 inches	Type C	5,000	Astec D.B. Green
		3 & 4 1/2 inches	Type B		
	US 190*	1 1/4 inches	SMA-F	29,600	Astec D.B. Green

*construction in progress

Projects Overview

District	Roadway	Lift Thickness	Mix Type	Approximate Tonnage	WMA Additive or Process
Waco	SH 6*	2 inches	Type C	24,000	Astec D.B. Green
		3 inches	Type B	39,500	
Wichita Falls	US 380	2 inches	Type D	68,500	Astec D.B. Green
	US 82	1 1/2 inches	Type D	7,200	Astec D.B. Green
	US 183	2 inches	Type D	34,800	Astec D.B. Green
	US 277	4 inches	Type C	72,700	Terex

693,700 Total Tonnage of WMA Produced & Placed as of October 2009
(plus 563,200 tons under construction)

*construction in progress

WMA, RAP & RAS



How Bout Them Cowboys?

Loop 368 - San Antonio

- ~ 1200 tons (Evotherm)
- AC Content
 - Control - PG 76-22, 4.8%
 - Warm Mix - PG 76-22 (after mod), 4.8%
- Temperature (plant)
 - Control 320°F
 - Warm Mix 220°F
- Laydown and Compaction
 - Same roller pattern on control and warm mix.
 - No problems during laydown and compaction.
 - Traffic allowed in some areas as soon as 2 hours after placement



Loop 368 - San Antonio



Absorption



TxDOT Cores After 1 Year



Hot Mix

No Distress Evident after One Year of Service



After Two Years of Service



Hamburg-One Year Cores



US 287 - Fort Worth



US 287 - Fort Worth



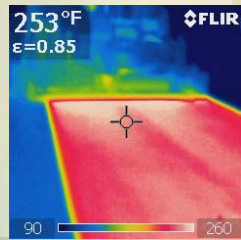
US 380 - Young Co.



US 380 – Plant Modification



US 380 – Young Co.



FM 324, Lufkin

- 800 tons of Sasobit
- 800 tons of Evotherm
- 800 tons of Advera
- 800 tons of Akzo Nobel's (RediSet)
- HMA (rest of job)
- WMA produced at 260°F.



FM 324 - Lufkin



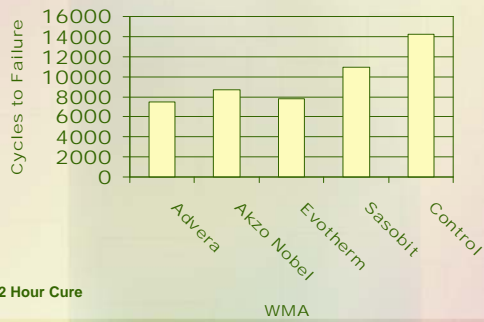
WMA



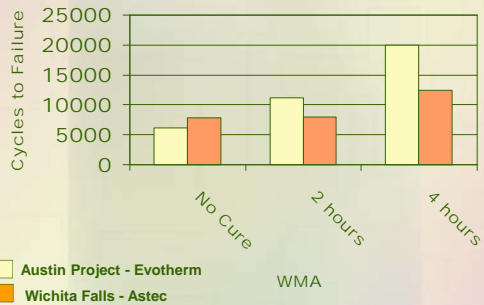
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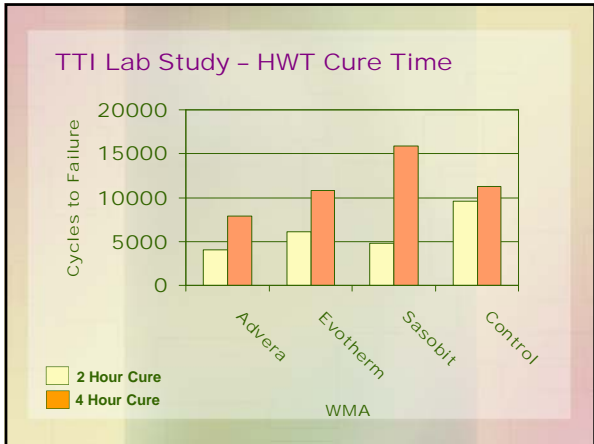


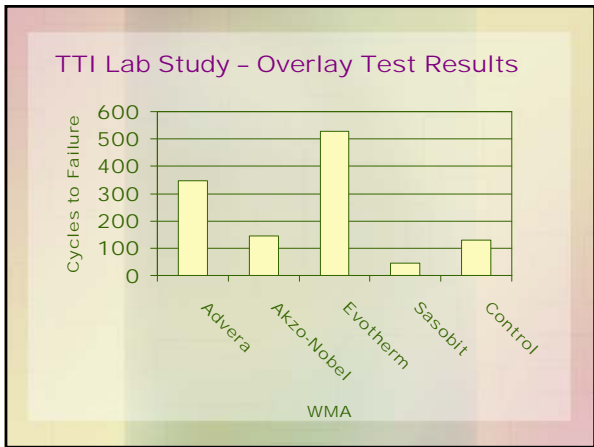
HWT Testing - Lufkin

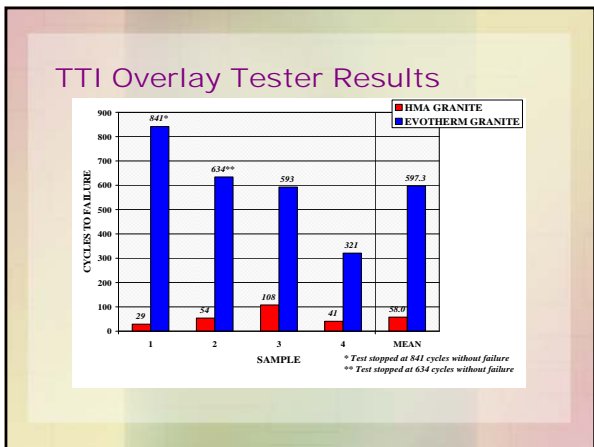


HWT Testing - Effects of Cure Time

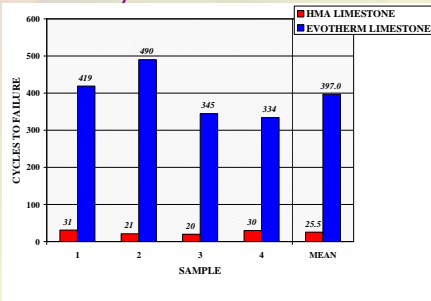








TTI Overlay Tester Results



WMA Summary

- TxDOT allows WMA on all projects and requires WMA on some projects
- Overall performance has been good
- Significant increase in cracking resistance - Overlay Tester
- Less compactive effort required
- Less asphalt absorption
- More difficulty in meeting TxDOT's Hamburg requirement
- WMA is relatively insensitive to variations in compaction temperature

TxDOT's Use of RAP

- In 2005 TxDOT Used 15 million tons of HMA and only 300,000 tons of RAP (~2%)
- SPS-5 Test Section Demonstrated HMA with 35% RAP Performed Well for Over 17 Years
- In 2009 TxDOT Used ~ 9 million tons of HMA and 900,000 tons of RAP (~10%)
- Funding shortages, asphalt prices and availability have put more emphasis on RAP
- Fractionated RAP has lead to increased confidence in RAP usage

New Special Provision

- *SP 341-024*
 - *Mandatory on all projects with Item 341*
 - *Gives the contractor the option to use up to 5% RAS in HMA*

**Table 1A
Maximum Allowable Amounts of Recycled Binder, RAP & RAS**

Mixture Description & Location	Maximum Ratio of Recycled Binder ¹ to Total Binder (%)	Maximum Allowable % (Percentage by Weight of Total Mixture)		
		Unfractionated RAP ²	Fractionated RAP ³	RAS ⁴
Surface Mixes ⁵	35	10	20	5
Non-Surface Mixes ⁶ < 8 in. From Final Riding Surface	40	15	30	5
Non-Surface Mixes ⁶ > 8 in. From Final Riding Surface	45	20	40	5

What's coming?

**Table 3A – SP341-024
Allowable Substitute PG Binders**

<i>PG Binder Originally Specified</i>	<i>Allowable Substitute PG Binders</i>
<i>PG 76-22</i>	<i>PG 70-22 or PG 64-22</i>
<i>PG 70-22</i>	<i>PG 64-22 or PG 58-22</i>
<i>PG 64-22</i>	<i>PG 58-22</i>
<i>PG 76-28</i>	<i>PG 70-28 or PG 64-28</i>
<i>PG 70-28</i>	<i>PG 64-28 or PG 58-28</i>
<i>PG 64-28</i>	<i>PG 58-28</i>

Assumptions Used for HMA Cost Estimates

<i>Material</i>	<i>Cost Per Ton</i>	<i>Notes</i>
<i>Aggregate</i>	<i>\$22</i>	<i>Includes processing & freight</i>
<i>PG 76-22</i>	<i>\$538</i>	<i>Based on September 2009 *Index (freight not included)</i>
<i>PG 70-22</i>	<i>\$480</i>	<i>Based on September 2009 *Index (freight not included)</i>
<i>PG 64-22</i>	<i>\$377</i>	<i>Based on September 2009 *Index (freight not included)</i>
<i>RAP</i>	<i>\$15</i>	<i>Contains 5% AC, includes processing & freight</i>
<i>RAS</i>	<i>\$20</i>	<i>Contains 20% AC, includes processing & freight</i>

** Source: Louisiana Asphalt Pavement Association*

Cost of Mix (\$/Ton)					
Binder Grade	Virgin Mix	20% RAP	5% RAS	15% RAP+ 5% RAS	*One Grade Substitute
PG 76-22	47.80	41.24	42.54	37.64	35.74
PG 70-22	44.90	38.92	40.22	35.74	32.39
PG 64-22	39.75	34.80	36.10	32.39	NA

* Includes 15% RAP and 5% RAS

Conclusions

- TxDOT typically uses between 5 million and 15 million tons of HMA annually
- Substitute Binders, RAP & RAS Can Save ≈ 10% to 30% on the Cost of HMA
- Assuming HMA average cost of \$45/ton (material only) and only 10% saving, TxDOT could save \$22.5 million to \$67.5 million annually by using RAP, RAS and substitute binders
- The potential cost savings are thought to far outweigh potential risks

Incentives to Use Pave-IR System

- Currently the Minimum Surface Temperature Prior to Paving Must be 50F - 70F
- Currently Contractors are Required to Run Thermal and Density Profiles on Every Sublot and Failing Result - Waive QCQA Bonus
- Density Profiles Also Required Every Time Paver Stops and When Visual or Thermal Segregation is Identified.
- If Contractor uses Pave-IR System they can pave when Surface Temperature is 32F and Pavement is Dry and they do not have to Run Segregation or Density Profiles and are Not Subject to Waiving QCQA Bonus for Failing Thermal or Density Profile.
- Must Show Less than 25F Segregation when Pave-IR System is Used

Overall Goal of Pave-IR Implementation

- Improve Paving Quality By Having 100% Sampling for Thermal Segregation
- Passive Inspection?
- Contractors Can Fix Paving Problem if they See the Problem
- Contractors Are Allowed More Latitude if They Can Demonstrate They Have a Good Paving Practice



