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16. Abstract

A thin (1 inch–1.5 inch) hot-mix asphalt (HMA) overlay was constructed on Pumphrey Drive in Tarrant County, Fort Worth from July 30, 2007, to August 3, 2007. This report documents the mix design, construction, and field performance of this overlay project.

Two Type F mixes were designed for this project following the new proposed balanced mix design procedure. These two mixes had the same original PG64-22 binder, aggregates, and gradation but different binder modifiers. One mix was modified with 7 percent crumb rubber and the other modified with 3 percent SBR latex. After construction, three visual site inspections on this thin overlay project were conducted on December 14, 2007, April 2, 2008, and July 30, 2008. The overall performance of this thin HMA overlay project is very good and has been considered successful by TxDOT and Tarrant County. Almost no rutting was observed on the main traffic lanes, except at a stop condition intersection on the south end of the project. Only a few transverse reflective cracks occurred on the ramps and a few longitudinal cracks occurred on the main traffic lanes. Additionally, the pavement still looks dark after 1 year of being subject to traffic and the sun's UV rays. Some reflective cracking was seen at the on- and off-ramps and main traffic lanes but those cracks stayed mostly tightly closed and did not get worse since the first field visit on December 14, 2007. The early reflective cracking on the ramps was due to poor load transfer efficiency at the joints and on the main traffic lanes due to continual differential settlement of the foundation. The cracks were observed in the July 30 visit to be minimized from previous visits. Therefore, these thin overlays are not recommended to be used on any PCC pavements with poor load transfer efficiency (< 70 percent). Otherwise, the early reflective cracking will be a potential problem.

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MIX DESIGN, CONSTRUCTION, AND PERFORMANCE OF A THIN HMA OVERLAY ON PUMPHREY DRIVE, FORT WORTH, TX

by

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Project 5-5123-01
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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation. The engineer in charge was Dr. Fujie Zhou, P.E. (Texas, # 95969).

There is no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States of America or any foreign country.

ACKNOWLEDGMENTS

This project was made possible by the Texas Department of Transportation in cooperation with the Federal Highway Administration. The authors thank the many personnel who contributed to the coordination and accomplishment of the work presented herein. Special thanks are extended to Richard Williammee, P.E., for serving as the Implementation Director.

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INTRODUCTION

A thin (1 inch–1.5 inch) hot-mix asphalt (HMA) overlay was constructed on Pumphrey Drive in Fort Worth (FTW) from July 30, 2007, to August 3, 2007. Two Type F mixes were designed for this project following the new proposed balanced mix design procedure using the Hamburg and Overlay Tester test methods. These two mixes had the same original PG64-22 binder, aggregates, and gradation but different binder modifiers. One mix was modified with 7 percent crumb rubber and the other modified with 3 percent SBR latex. After construction, three visual site inspections on this thin overlay project were conducted on December 14, 2007, April 2, 2008, and July 30, 2008. The overall performance of this thin HMA overlay project is very good.

This report briefly summarizes the mix design, construction, visual observations, laboratory characterization of the plant mixes, and final recommendations. In the report, the plan view of the project is presented first followed by a brief discussion of the lab mix design, construction operations, and laboratory characterization of the plant mixes. The visual evaluations are then discussed, followed by a summary of the site observations and recommendations for future uses of these two mixes.

PLAN VIEW OF THE PROJECT

Figure 1 is a plan view of the overlay project on Pumphrey Drive in Fort Worth. The underlying pavement structure is an old jointed concrete pavement with interspaced transverse joints. Construction of this pavement overlay occurred between July 30 and August 3, 2007. All subsequent presentations and discussions in this report should be reviewed in conjunction with Figure 1.

MIX DESIGN

The mix-design characteristics of the crumb rubber and SBR latex materials are as follows with the detailed aggregate gradation sheets presented in Figures 2 and 3.

- **Type F mix with crumb rubber**

Mixture Type:	Type F Granite	
Aggregates:	Martin Marietta Materials, Mill Creek, OK	
	Producer Code 0050433	
	Surface Aggregate Class (SAC) – A	
Stockpiles:	F-Rock	55 %
	Screenings:	45 %
Asphalt:	Valero PG64-22 plus 7 % Crumb Rubber from Bridges Pavement Solutions Inc.	
Antistripping agent:	N/A	
Optimum asphalt content:	6.8 % based on Overlay Tester and Hamburg test results	

Mix properties at optimum asphalt content are:

VMA:	19.0 %
Bulk specific gravity:	2.316
Max. specific gravity:	2.398
Boil test, Tex-530-C:	No visual stripping
Overlay test, Tex-248F:	>1200 cycles
Hamburg test, Tex-242F:	<12.5 mm at 20,000 passes (meets PG76-22 requirement)

Special note: Special instruction for mix design has been provided by Bridges Pavement Solutions Inc., and this instruction should be followed during mix production in the plant. Otherwise, the performance of this mix may change.

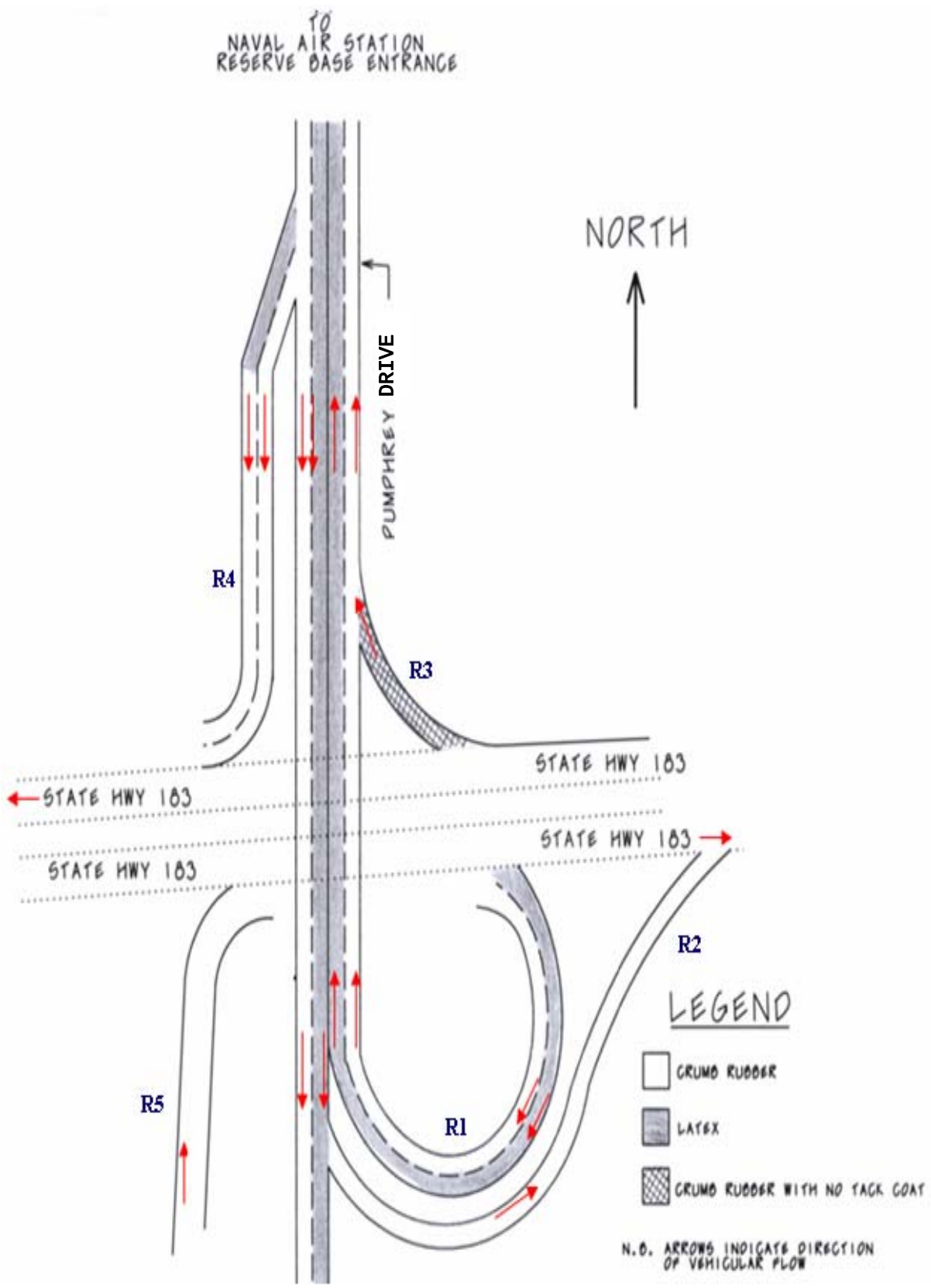

Figure 1. Plan View of the Pumphrey Drive Project (Drawing Not to Scale).

TEXAS DEPARTMENT OF TRANSPORTATION

HMACP MIXTURE DESIGN : COMBINED GRADATION

Refresh Workbook

File Version: 06/15/06 15:19:42

SAMPLE ID:		SAMPLE DATE:	
LOT NUMBER:		LETTING DATE:	
STATUS:		CONTROLLING CSJ:	
COUNTY:		SPEC YEAR:	2004
SAMPLED BY:		SPEC ITEM:	Type F
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL:	Type F mix	MIX TYPE:	Other
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:		CONTRACTOR DESIGN # :	

	BIN FRACTIONS																			
	Bin No.1		Bin No.2		Bin No.3		Bin No.4		Bin No.5		Bin No.6		Bin No.7							
Aggregate Source:																				
Aggregate Number:	F Rock		Screeings																	
Sample ID:															Combined Gradation					
Rap?, Asphalt%:															Total Bin					
Individual Bin (%):	55.0	Percent	45.0	Percent	0.0	Percent		Percent		Percent		Percent		Percent	100.0%	Lower & Upper Specification Limits			Restricted Zone	
Sieve Size:	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum.% Passing	*Wtd* Cum. %	Cum. % Passing			Within Spec's		Within Spec's
1"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes		
3/4"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes		
1/2"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes		
3/8"	98.8	54.3	100.0	45.0		0.0		0.0		0.0		0.0		0.0	99.3	98.0	100.0	Yes		
No. 4	52.6	28.9	92.6	41.7		0.0		0.0		0.0		0.0		0.0	70.6	70.0	90.0	Yes		
No. 8	20.6	11.3	72.9	32.8		0.0		0.0		0.0		0.0		0.0	44.1	40.0	65.0	Yes		
No. 16	9.8	5.4	55.3	24.9		0.0		0.0		0.0		0.0		0.0	30.3	20.0	45.0	Yes		
No. 30	4.5	2.5	40.7	18.3		0.0		0.0		0.0		0.0		0.0	20.8	10.0	30.0	Yes		
No. 50	2.4	1.3	27.7	12.5		0.0		0.0		0.0		0.0		0.0	13.8	10.0	20.0	Yes		
No. 200	1.1	0.6	11.8	5.3		0.0		0.0		0.0		0.0		0.0	5.9	2.0	10.0	Yes		

Not within specifications # Not cumulative

Asphalt Source & Grade:	Valero PG 64-22 plus 7% Crumb Rubber	Binder Percent, (%):	6.8	Asphalt Spec. Grav.:	1.025
Antistripping Agent:		Percent, (%):			

Remarks:

Test Method:	Tested By:	Tested Date:
TX207		
TX226		
TX227		
TX235		
TX242		
TX530		

Reviewed By:	Completed Date:

Authorized By:	Authorized Date:

Figure 2. Type F Mix with Crumb Rubber: Aggregate Gradation.

- **Type F mix with SBR latex**

Mixture Type:	Type F Granite	
Aggregates:	Martin Marietta Materials, Mill Creek, OK	
	Producer Code 0050433	
	Surface Aggregate Class (SAC) – A	
Stockpiles:	F-Rock	55 %
	Screenings:	45 %
Asphalt:	Valero PG64-22 plus 3 % UP7814 Anionic SBR Polymer (70 % min. Solid)	
Antistripping agent:	1% Akzo Nobel, Kling-Beta 2550	
Optimum asphalt content:	6.8 % based on Overlay Tester and Hamburg test results	

Mixture properties at optimum asphalt content are:

VMA:	18.8 %
Bulk specific gravity:	2.317
Max. specific gravity:	2.399
Boil test, Tex-530-C:	No visual stripping
Overlay test, Tex-248F:	>1200 cycles
Hamburg test, Tex-242F:	10.5 mm at 20,000 passes (meets PG76-22 requirement)

TEXAS DEPARTMENT OF TRANSPORTATION

HMACP MIXTURE DESIGN : COMBINED GRADATION

Refresh Workbook

File Version: 06/15/06 15:19:42

SAMPLE ID:		SAMPLE DATE:	
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SAMPLED BY:		SPEC ITEM:	Type F
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL:	Type F mix	MIX TYPE:	Other
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:		CONTRACTOR DESIGN # :	

	BIN FRACTIONS						
	Bin No.1	Bin No.2	Bin No.3	Bin No.4	Bin No.5	Bin No.6	Bin No.7
Aggregate Source:							
Aggregate Number:	F Rock	Screenings					
Sample ID:							
Rap?, Asphalt%:							
Individual Bin (%):	55.0 Percent	45.0 Percent	0.0 Percent	Percent	Percent	Percent	Percent

Sieve Size:	Bin No.1 Cum.% Passing	Bin No.1 Wtd Cum. %	Bin No.2 Cum.% Passing	Bin No.2 Wtd Cum. %	Bin No.3 Cum.% Passing	Bin No.3 Wtd Cum. %	Bin No.4 Cum.% Passing	Bin No.4 Wtd Cum. %	Bin No.5 Cum.% Passing	Bin No.5 Wtd Cum. %	Bin No.6 Cum.% Passing	Bin No.6 Wtd Cum. %	Bin No.7 Cum.% Passing	Bin No.7 Wtd Cum. %	Combined Gradation Total Bin Cum. % Passing	Lower & Upper Specification Limits		Within Spec's	Restricted Zone		Within Spec's
															100.0%						
1"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes			
3/4"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes			
1/2"	100.0	55.0	100.0	45.0		0.0		0.0		0.0		0.0		0.0	100.0	100.0	100.0	Yes			
3/8"	98.8	54.3	100.0	45.0		0.0		0.0		0.0		0.0		0.0	99.3	98.0	100.0	Yes			
No. 4	52.6	28.9	92.6	41.7		0.0		0.0		0.0		0.0		0.0	70.6	70.0	90.0	Yes			
No. 8	20.6	11.3	72.9	32.8		0.0		0.0		0.0		0.0		0.0	44.1	40.0	65.0	Yes			
No. 16	9.8	5.4	55.3	24.9		0.0		0.0		0.0		0.0		0.0	30.3	20.0	45.0	Yes			
No. 30	4.5	2.5	40.7	18.3		0.0		0.0		0.0		0.0		0.0	20.8	10.0	30.0	Yes			
No. 50	2.4	1.3	27.7	12.5		0.0		0.0		0.0		0.0		0.0	13.8	10.0	20.0	Yes			
No. 200	1.1	0.6	11.8	5.3		0.0		0.0		0.0		0.0		0.0	5.9	2.0	10.0	Yes			

Not within specifications # Not cumulative

Asphalt Source & Grade:	Valero PG 64-22 plus 3% Latex (70% Solid)	Binder Percent, (%):	6.8	Asphalt Spec. Grav.:	1.025
Antistripping Agent:	Liquid Antistrip	Percent, (%):	1		

Remarks:

Test Method:	Tested By:	Tested Date:
TX207		
TX226		
TX227		
TX235		
TX242		
TX530		

Reviewed By:	Completed Date:

Authorized By:	Authorized Date:

Figure 3. Type F Mix with SBR Latex: Aggregate Gradation.

EXISTING PCC PAVEMENT CONDITIONS AND REPAIRS

Both Richard Williammee, P.E., Fort Worth District Materials Engineer and the TTI researchers evaluated the existing PCC pavement conditions on June 14, 2007, and made recommendations on the areas that needed to be repaired before the thin HMA overlay. The main distress observed was spalling at the joints. The overall conditions of the main traffic lanes were acceptable except in two large areas with longitudinal cracks, settlements, and block cracking. Figure 4 shows examples of the existing conditions of the main traffic lanes before the HMA overlay. The general conditions of the PCC pavement on the ramps were worse than those of the main traffic lanes as shown in Figure 5. Figure 6 presents some areas after full depth repairs were made.

Figure 4. Observed Distresses on the Main Traffic Lanes, Pumphrey Drive, FTW.

Figure 5. Observed Distresses on the Ramps, Pumphrey Drive, FTW.

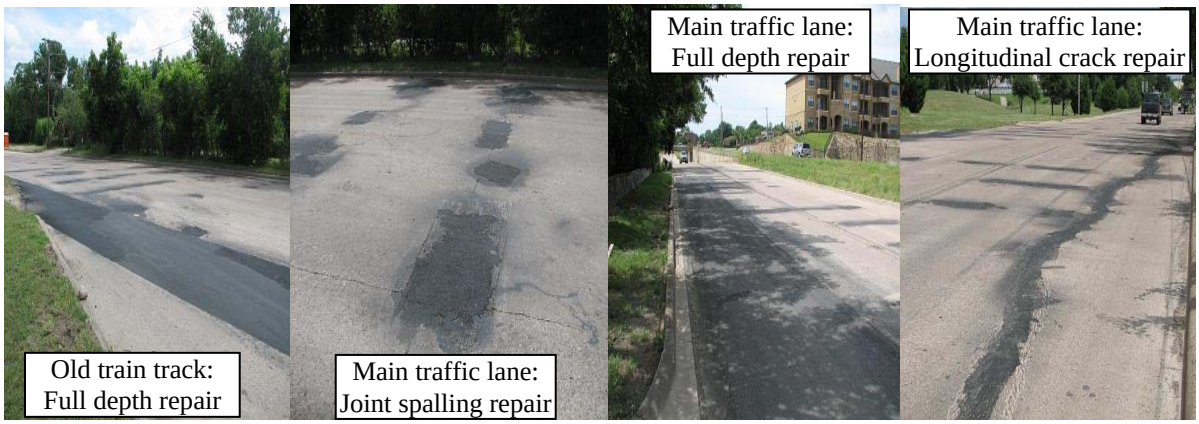

Figure 6. Repairs of Existing Distresses before the HMA Overlay.

CONSTRUCTION OPERATIONS

Pavement Surface Preparation

Typical pavement surface preparatory practices were followed. The pavement surface was swept and tack coated prior to the HMA placement. However, as shown by the cross hatching in Figure 1, one off-ramp was intentionally not tack coated as an experimental section. This was an experiment requested by the crumb rubber modifier supplier to assess the claim that the crumb rubber would hold onto the existing pavement surface without any tack coat.

HMA Placement and the Paving Process

The pavement surface temperature was about 106 °F which meets the CAM SS 3109 recommendations (TxDOT, 2004b). According to the Tarrant County construction crew, the air temperature should at least be 42 °F and rising for laydown operations such as the Pumphrey Drive project. The air temperature was about 78 °F at the start of the construction operation which satisfied the ≥ 42 °F recommendation. No material transfer device was engaged in this laydown operation. The trucks dumped the hot mix directly into the paver. This operation is shown in Figure 7.

It is worth noting that two overlay mat thicknesses were used in this overlay project due to different traffic levels. The HMA overlay was 1.5 inch thick starting from the Naval Air Base Entrance to the middle of the overlay project where the traffic volume is much higher than the rest of the project in which only 1 inch thick mat was used.

Figure 7. Paver Operation on the Pumphrey Drive, FTW.

Infra-Red Temperature Measurements

The Texas Transportation Institute (TTI) conducted Infra-Red (IR) temperature measurements on this project during placement of the crumb rubber mix on the outside lane starting at the Naval Air Station entrance and heading southbound toward SH 183. The IR set-up and measurement bar is shown in Figure 8. This device was constructed and installed on the County's paver by TTI. The IR-measured mat surface temperature profiles are shown in Figure 9.

Figure 8. Temperature Measurement Using the Infra-Red Bar during Construction.

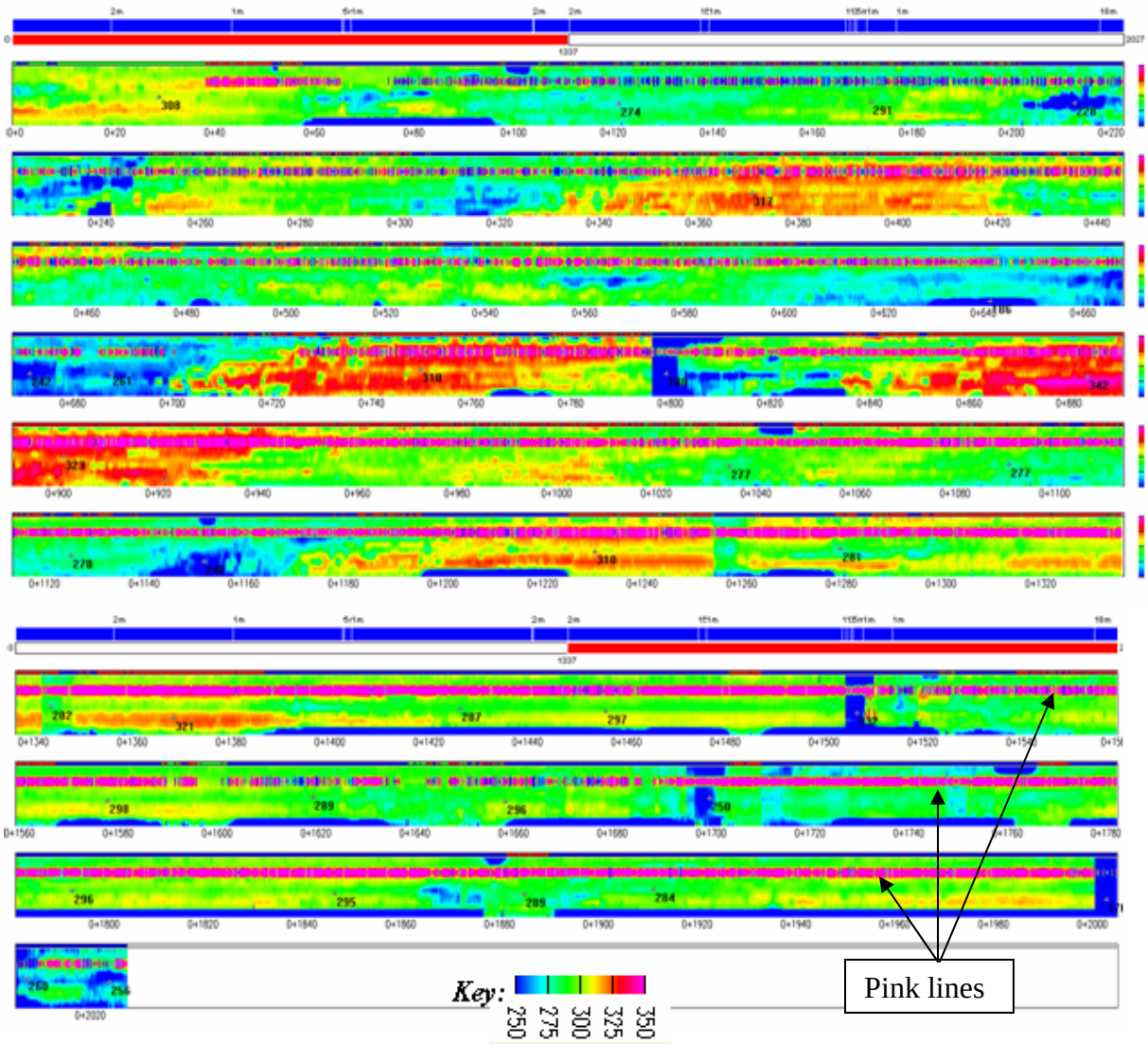

Figure 9. IR Thermal Profiles Measured on Pumphrey Drive (Crumb Rubber Mix).

Figure 9 is the surface temperature profile of the full lane width for 2027 ft of new mix. The distance scale is under each plot. The key for the different colors is also shown in the bottom center of the figure.

The numbers on the plot are the actual temperatures at that location. The pink uniform horizontal line across each temperature bar profile is not to be considered as a reading or measurement. It is an indication of a loose connection or a dysfunctional IR sensor. In general, blue is an undesirable IR thermal color reading as it often indicates cold spots. For a target mat placement temperature of 300 °F with a tolerance of ±30 °F, the green and red IR thermal color readings would be considered as acceptable. Also, a consistently uniform IR thermal color

reading, such as just green or red, indicates uniform mat temperature which is desired. Colors above the red indicate a mix that is too hot and may be damaged if not lowered. The blue strips at the edges indicate points where the IR sensors had passed over the curb and are not to be considered in the thermal data analysis and interpretations.

The average mat temperature was about 290 °F. But, as shown in Figure 9, the mat temperature was hardly uniform. There are some intermittent sections of green (about 290 °F) and red (about 318 °F) IR thermal color readings which could be a cause for concern with respect to uniformity in the compaction operation. There is clear visual evidence of intermittent cold spots (bluish) indicating potential thermal segregation in the mat. These cold spots were predominantly caused by paver stops and most often coincided with the end of every truckload of HMA caused by irregular mix delivery due to an inadequate number available for hauling. In more than two instances, the paver was stopped for over 20 minutes while waiting for the truckloads of HMA. Furthermore, as can be seen from Figure 9, there was a significant variation in the HMA temperature of the truckloads; some were hotter, while some were colder. Additionally during this period, daily afternoon thunderstorms formed and, on at least 3 different days, moderate to heavy amounts of rain hit the laydown operation. The crew leader would normally continue to pave with the mix from the trucks that were already on the jobsite or on their way from the plant. Then they would quit for the day.

These thermal variations may have an impact on the compaction operation, which could lead to non-uniformity in the target compaction thickness and having other defects such as bumps in the completed mat. In particular, researchers observed that more compaction rolling passes were applied on the cold sections to attain the target 1 inch thickness. The planned comparative performance monitoring program of this project will allow an opportunity to monitor the effect of these thermal variations and cold spots on performance.

Compaction

Two steel rollers, an 18 ton and 5 ton as shown in Figure 10, were used in the static mode for the compaction operation on the southbound outside lane. The 18-ton roller was used for the mix breakdown in two to four passes with the 5 ton roller used as the finishing roller at two to three passes. Rolling compaction in vibration mode was only conducted at the joints.

Figure 10. Rolling Compaction – Tarrant County 18- and 5-Ton Rollers.

To accelerate the compaction operation, two 18-ton steel rollers at about two passes each were used on all the other lanes for both the crumb rubber and SBR latex mixes. One of the 18-ton breakdown rollers generally followed just behind the paver, but there were a few instances where this pattern was not followed. Additionally, there were some instances of increased rolling passes such as on the cold spots or after long spells of paver stoppage. No density measurements were conducted; only the 1-inch mat thickness was monitored.

In general, the laydown crew reported that the SBR latex mix was comparatively less workable; it was very sticky and difficult to hand work. By contrast, the crumb rubber required more rolling passes to attain the target mat thickness. The laydown crew also reported that the crumb rubber retained heat much longer than the SBR latex mix.

Finished HMA Surface

Figure 11 shows the completed surfaces for both the crumb rubber and SBR latex mixes. It is clear from Figure 11 that the SBR latex mix had more open appearance than that of the crumb rubber mix. Nonetheless, the mixes' performance were monitored and compared.

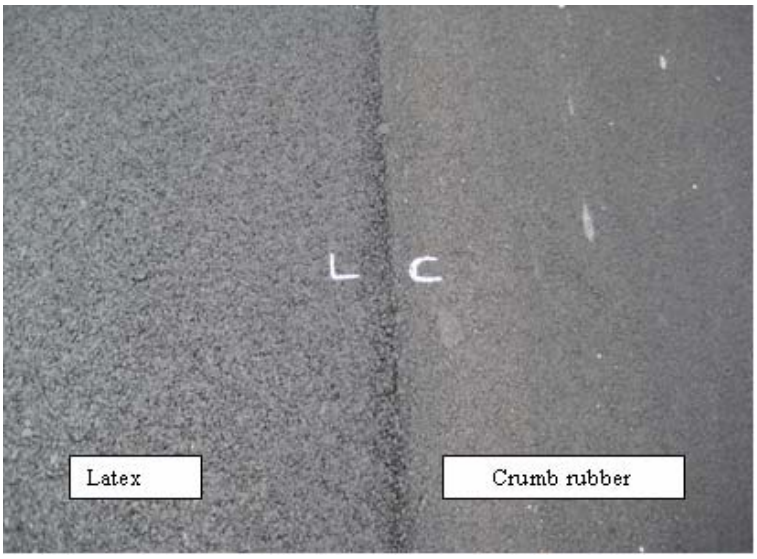

Figure 11. Finished HMA Surface – SBR Latex and Crumb Rubber Mixes.

Apart from expressing difficulties in working with the SBR latex mix, the Tarrant County laydown crew did not report any major problems besides the rains disrupting the laydown operations.

FIELD PERFORMANCE

Three on-site inspections of the HMA overlays placed on Pumphrey Drive in Fort Worth were conducted on December 14, 2007, April 2, 2008, and July 30, 2008, respectively. The overall performance of the test sections is very good. A summary of the site observations are presented as follows:

Rutting

Generally, no rutting was observed on both the main traffic lanes and the ramps (Figure 12). The only area with rutting was in the SBR latex southbound lane at the Stop sign at the intersection with Roaring Springs Road (Figure 13). This is not unexpected due to slow and stopped traffic loading and higher binder content (7.2 percent) than the design binder content (6.8 percent).

Figure 12. No Rut on the Main Traffic Lanes and Ramps.

Figure 13. Observed Rut at the Stop Sign at Roaring Springs Road.

Cracking Observation

- **Overview of the Main Lanes**

As shown in all four views of Figure 14, the overall performance of this experimental test section is very good. Almost no transverse reflective cracking was observed anytime during the first year's performance.

(14a). Overview of the Main Lanes between SH183 and the Naval Air Base Entrance.

(14b). Overview of the Main Lanes South of SH183.

(14c). Overview of the Main Lanes in the Middle of the Project.

(14d). No Transverse Reflective Cracking: A Closer Look

Figure 14. Field Observations of the Main Traffic Lanes.

- **Longitudinal Cracking**

There was visual evidence of longitudinal cracking in the outside northbound lane in two locations of the section toward the Naval Air Base entrance as shown in Figure 15. These two longitudinal cracks are considered to be caused by continual differential settlement of the foundation (Figures 4 and 6) which was also earlier observed on December 14, 2007. They still look the same as when observed the first time in July 2007 before the overlay placement.

- **Transverse Reflective Cracking on the Ramps**

Transverse cracking reflecting through the thin overlay from the underlying jointed concrete pavement structure was the predominant surface distress that was visually observed on the ramps. Figure 16 shows examples of typical transverse cracks that appeared on the ramps within the project mix overlay. Again, these transverse reflective cracks were observed during the first visit on December 14, 2007, and did not worsen when seen again during the visit on April 2, 2008. During the last visit on July 30, 2008, some of the reflected cracks were found to be healed. Engineering opinion as to the reasons were: 1) hot summer temperatures softening the asphalt binder, and 2) kneading under the traffic loading.

- **Bumps/Humps due to Crack Sealant Material**

In addition to normal transverse cracking, bumps/humps transversely manifested during the initial compaction process along the underlying concrete joints on off-ramp R3 which was not tack coated at the time of the crumb rubber mix placement. In total, up to five regularly interspaced bump/humps, consistent with the concrete joints, were visually counted. These bumps/humps are considered to have been caused by the liquification and expansion of the crack sealant material at the time of the overlay placement. During placement, the laydown crew reported some compaction problems on this section citing expansion of the crack sealant under the hot-mix as the probable cause. Ramp R3 is the only section manifesting this problem. Figure 17 shows an example of the bumps/humps on Ramp R3.

Figure 15. Longitudinal Cracking Manifesting in the Outside Northbound Main Lane toward the Naval Air Base Entrance.

Figure 16. Examples of Transverse Reflective Cracking on Ramp R4.

Figure 17. Example of Humps on Off-Ramp R3.

- **Other Visual Observations**

In general, the bonding between the HMA overlay and the underlying concrete structure appeared satisfactory on all the sections without any visual evidence of delaminating. Even the crumb rubber mix, which was placed directly on the swept concrete surface without any tack coat, was holding without any indication of debonding.

In Summary

In general, the main lanes (both with crumb rubber and SBR latex surfaces) appear to be performing well. Periodic reflections of the transverse cracks through the thin overlay were observed on the ramps but these cracks are still in very good shape and have not gotten worse. Two longitudinal cracks were also evident on the main northbound lanes of SH183, but this is primarily due to differential settlement of the foundation.

LABORATORY CHARACTERIZATION OF THE PLANT MIXES AND FIELD PERFORMANCE PREDICTION

During construction, the plant mixes were sampled for a series of lab characterization tests including Overlay Tester, Hamburg, and dynamic modulus tests. The plant mixes were molded at 4-5 percent air voids for the lab testing using the Superpave Gyratory Compactor. The Hamburg and Overlay test results are shown in Table 1. Both mixes passed the Overlay Tester requirement (>900 cycles) but only the crumb rubber mix passed the Hamburg test. The higher than Optimum Asphalt Content (OAC) (7.2 percent versus 6.8 percent) could be one of the contributing factors for the SBR latex mix's poor laboratory performance in the Hamburg test. However, it is worth noting that SBR latex mixes have historically failed the Hamburg test for the last 10 years, but these mixes have lasted up to 22 years in the field in Fort Worth District.

Table 1. Test Results at 4-5 Percent Air Voids - Crumb Rubber and SBR Latex Mixes.

Mix	Asphalt binder (plant mix)	Specimen air void	OT (Cycles to failure)	Hamburg	
				Number of load passes	Rut depth (mm)
7% crumb rubber	6.6%	4.7%	900+	20,000	11.26
3% SBR latex	7.2%	4.38%	900+	17,890	13.47

Figure 18 shows the dynamic modulus master curves of these two mixes. The fracture properties (A and n) measured at room temperature are also presented in Figure 18. With all this information plus the data from the Fort Worth, Texas weather station, the reflective cracking performance of these two test sections on both the main traffic lanes and the ramps were predicted by the asphalt overlay thickness design and analysis program developed under TxDOT's Research Project 0-5123. The results were compared to the observed reflective cracking and are shown in Figure 19. It can be seen that the prediction generally matches what has been observed in the field.

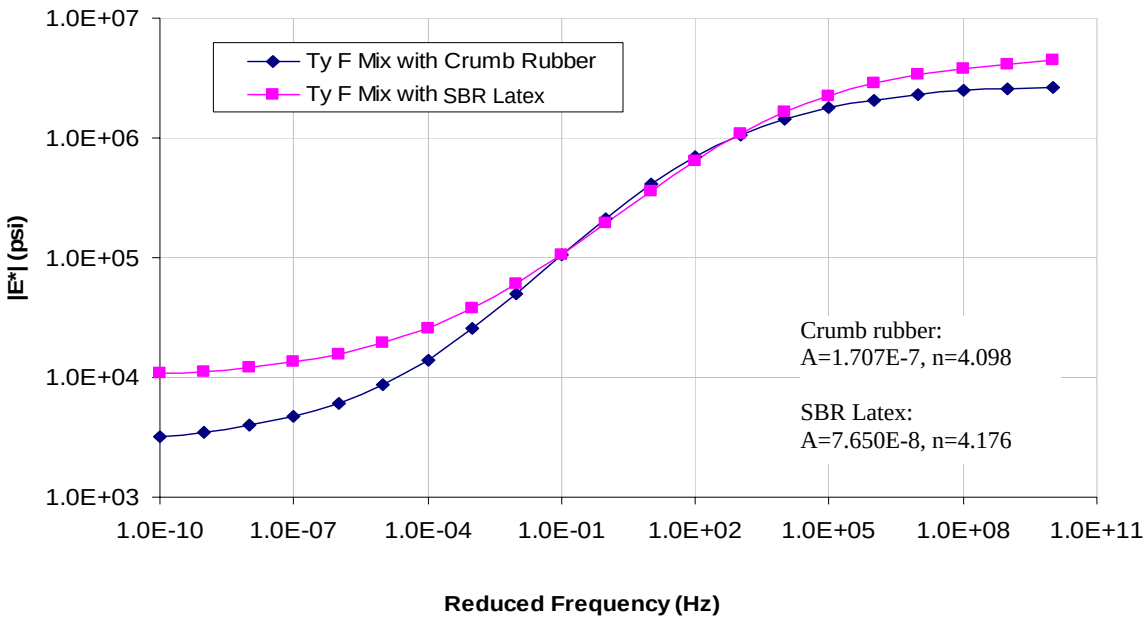

Figure 18. Dynamic Moduli of the Mixes with Crumb Rubber and SBR Latex.

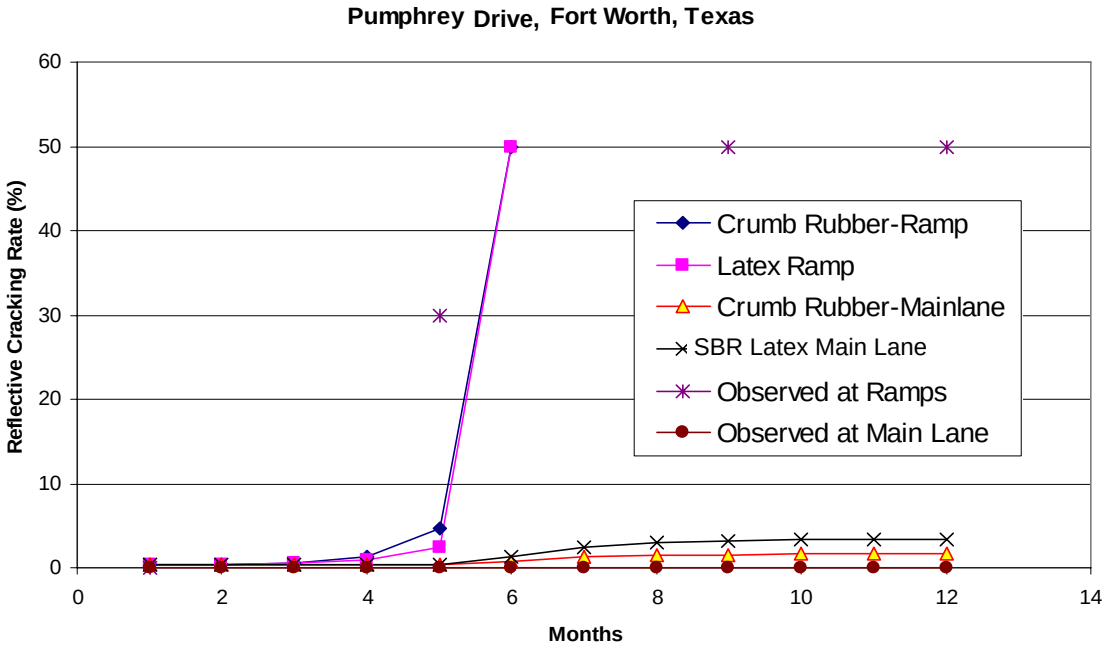

Figure 19. Pumphrey Drive: Reflective Cracking Prediction.

SUMMARY AND RECOMMENDATIONS

As reported above, the overall performance of the HMA overlay sections on Pumphrey Drive is very good and has been considered successful by TxDOT and Tarrant County. No rutting was observed on the main traffic lanes, and only a few transverse reflective cracks occurred on the ramps. Additionally, the pavement still looks dark after 1 year of being subject to traffic and the sun's UV rays. Some reflective cracking was seen at the on- and off-ramps but those cracks stayed mostly tightly closed and did not get worse since the first field visit on December 14, 2007. The early reflective cracking on the ramps was due to poor load transfer efficiency at the joints. Therefore, these thin overlays are not recommended to be used on any PCC pavements with poor load transfer efficiency (< 70 percent). Otherwise, the early reflective cracking will be a potential problem.

Some rutting did appear at a spot close to a traffic Stop sign where the traffic moves very slowly while decelerating and followed by a full stop at any Stop sign. It is well known that slow and stopped traffic can make the mix "soft"and consequently lead to rutting. Therefore, these 1 inch thick fine mixes may not be good for locations with slow and/or stopped traffic, thereby requiring more stiff mixes or thicker mats for these areas.