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INTERIM REPORT

INVESTIGATION OF TWO-INCH SURFACE RECYCLE PROCESS IN KANSAS ON US-59 SOUTH OF NORTONVILLE

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Topeka, Kansas

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16 Abstract

The two (2) inch hot surface recycle process for asphalt pavement preservation is relatively new to Kansas. The hot recycling process uses six (6) propane heating units, three (3) milling machines and a paving machine to achieve a two-inch total depth of recycled material. This recycled layer is then covered with a 1 to 1½ inch thick overlay wearing surface.

This investigation was to determine the changes in the pavement properties as the old pavement surface material is processed by the recycling operation during construction. This specific project was in Jefferson County on US-59 south of Nortonville. The before and after asphalt content and thermal cracking properties were looked at, as well as the gradation and potential rutting stability of the recycled mixture. This was not a full in-depth study, but rather, an initial preliminary review of the process.

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INTRODUCTION

The two (2) inch hot surface recycle process for asphalt pavement preservation is relatively new to Kansas. The hot recycling process uses six (6) propane heating units, three (3) milling machines and a paving machine to achieve a two-inch total depth of recycled material. This recycled layer is then covered with a 1 to 1½ inch thick overlay wearing surface.

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RESEARCH APPROACH

The approach was to obtain Hot Mix Asphalt (HMA) material from five (5) different station locations along the project length and to do the testing at the Materials & Research Center (MRC) in Topeka. Generally, material with and without rejuvenating agent was obtained at each station; however, at one station only material with rejuvenating agent was obtained.

The HMA material was collected by the on-site KDOT Construction personnel from the windrow of processed material and then they delivered the material to the MRC Asphalt Laboratory. The Research Asphalt Laboratory personnel performed all the testing for this investigation.

The theoretical maximum specific gravity (Gmm) of each specimen was determined from the loose HMA material. An ignition oven test (KT-57) was used to determine the percent asphalt content of each specimen and the aggregate gradation was found from a sieve analysis of the aggregate after the ignition oven burnoff.

The loose mix was compacted with the Superpave Gyratory Compactor and the plug cored to obtain specimens for the Thermal Stress Restrained Specimen Test (TSRST). The TSRST equipment was used to obtain the cold temperature vs. stress relationship of the material from two locations for both the before and after the addition of rejuvenating agent cases. The test restrains the specimen from changing length while lowering the temperature until tensile fracture of the specimen occurs. The data generated gives an approximation of the low temperature cracking characteristics of the binder.

The Gyratory Testing Machine (GTM), sometimes referred to as the Corps of Engineers Gyratory, was used to determine the stability of the compacted mix which is related to the rutting potential.

DISCUSSION OF RESULTS

The SemMaterials Mix Design gradation is much courser than the actual final field gradation. It should be noted, however, that the Sem gradation is from cores that were cut to two inch lengths and then crushed to pass through a one inch screen.

The final gradation in front of the paver pick-up unit is slightly finer than the gradation just prior to the last milling operation and the addition of the rejuvenating agent. This could imply that the milling operations break the aggregate into smaller pieces. The final gradation at Station 250+00 is finer than the final gradations at the other locations, and all of the other locations had nearly identical gradations. Visual observation at Station 350+00 in the southbound lane revealed that many of the larger original aggregate pieces were being broken by the milling operation. The original pavement gradation was not reviewed as part of this investigation. Refer to Table A1 in Appendix A for the gradation data.

The Gmm before the rejuvenating agent was added averaged 2.462 with a range of 2.449 to 2.469 and after the rejuvenating agent was added averaged 2.427 with a range of 2.416 to 2.437. Refer to Table A2 in Appendix A for the Gmm data.

The Asphalt Binder Content averaged 5.11% with a range of 4.88 to 5.35% before the rejuvenating agent was added and after the rejuvenating agent was added averaged 5.94% with a range from 5.57 to 6.33%. The percent of asphalt binder added ranged from 0.67 to 1.42% at the tested locations; however, appears to be constant later in the project around 0.68%. Refer to Table A2 in Appendix A for the percent asphalt data.

The TSRST data indicates that the cold temperature cracking resistance increased from an average of -20.9ºC before the rejuvenating agent was added to -25.7 ºC after the rejuvenating agent was added for an increase of approximately 25%. These temperatures are a close approximation of the “low temperature grade” of the binder. Also, the transition temperature, where the mixture starts to act brittle rather than flexible, went from -12.3ºC to -20.8ºC for an approximate 70% increase. Refer to Table A3 in Appendix A for the TSRST data.

The data from the GTM testing indicates that the addition of the rejuvenating agent caused the mixture to go “unstable” or be susceptible to rutting. This would be of great concern if this recycled layer was the wearing surface; however, since the overlay is the wearing surface there is less, if any, concern. Refer to Table A4 in Appendix A for the Gmm data.

RECOMMENDATIONS

The sieve analysis data suggests that SemMaterials should consider revising their mix design development process to include a more realistic aggregate gradation. A method similar to that presently used for Cold In-Place Recycling mix design development could potentially be of benefit to this process.

The pavement aggregate gradation prior to this recycling project should be investigated if there is any concern about the milling operations breaking and reducing the aggregate gradation size. A large difference between the original gradation and the final gradation would indicate the milling operations were indeed breaking aggregate. The type of aggregate in the top two inches of the pavement may need to be considered before selecting this process if the finer gradation of the recycled material is a concern.

The MRC Research Asphalt Unit and other KDOT personnel should continue to monitor this section of US-59 for signs of rutting.

APPENDIX A

Table A1 Sieve Analysis Data

KT-57 Sieve Analysis - 59-106 KA 0316-01 (2" Surface Recycle) (See Notes below) (% Retained)														
Location / Size	Sta 250+00 SBL W/O	Sta 250+00 SBL W/ARA-1P	Sta 350+00 SBL W/ARA-1P	Sta 44+50 SBL W/O	Sta 44+50 SBL W/ARA-1P	Sta 540+00 SBL W/O	Sta 540+00 SBL W/ARA-1P	Sta 560+00 SBL W/O	Sta 560+00 SBL W/ARA-1P	Average of all locations **(W & W/O)**	Average of all locations **W/O**	Average of all locations **W/ARA-1P**		Sem Mix Design
3/4"	0	0	0	0	0	0	0	0	0	0	0	0		9
1/2"	6	1	5	5	6	5	4	7	6	5	6	4		42
3/8"	15	7	15	18	15	13	10	19	15	14	16	12		51
#4	38	28	34	36	34	32	30	41	35	34	37	32		72
#8	52	43	49	50	48	47	46	55	49	49	51	47		82
#16	61	54	59	59	57	58	57	63	60	59	60	57		88
#30	72	68	71	69	68	71	70	74	71	70	72	70		94
#50	84	83	84	83	82	85	85	87	85	84	85	84		97
#100	90	90	90	90	89	91	90	92	91	90	91	90		99
#200	91.5	90.8	91.0	91.9	90.6	91.7	91.5	92.7	91.8	92	92	91		99.5

Note 1: Sample location for without binder added (W/O) sample is just prior to final heater & mill unit
Note 2: Sample location for with binder added (W/ARA-1P) sample is just prior to the pickup unit for the paver
Note 3: Final gradation at loc. 250+00 is finer than final gradation at other locations

Table A2: Gmm & % Asphalt Data

59-106 KA 0316-01 2" Surface Recycle							
Location	**Mix**	**Moisture***	**Gmm W/O**	**Gmm W/ARA-1P**	**% Asphalt W/O**	**% Asphalt W/ARA-1P**	**% Asphalt added**
Sta 250+00 SBL	W/O ARA-1P	0.19%	2.469		4.91		
Sta 250+00 SBL	W/ARA-1P	0.08%		2.416		6.33	1.42
Sta 350+00 SBL	W/ARA-1P	0.17%		2.427		5.78	---
Sta 44+50 SBL	W/O ARA-1P	0.19%	2.449		5.35		
Sta 44+50 SBL	W/ARA-1P	0.18%		2.425		6.03	0.68
Sta 540+00 SBL	W/O ARA-1P		2.461		5.30		
Sta 540+00 SBL	W/ARA-1P			2.43		5.97	0.67
Sta 560+00 SBL	W/O ARA-1P		2.469		4.88		
Sta 560+00 SBL	W/ARA-1P			2.437		5.57	0.69
		Column Average	2.462	2.427	5.11	5.94	

*Moisture Test: The tests were performed on material brought into the Lab, preheated once at 110º C to split out samples, then followed KT-16 Step e., Alternate Method.

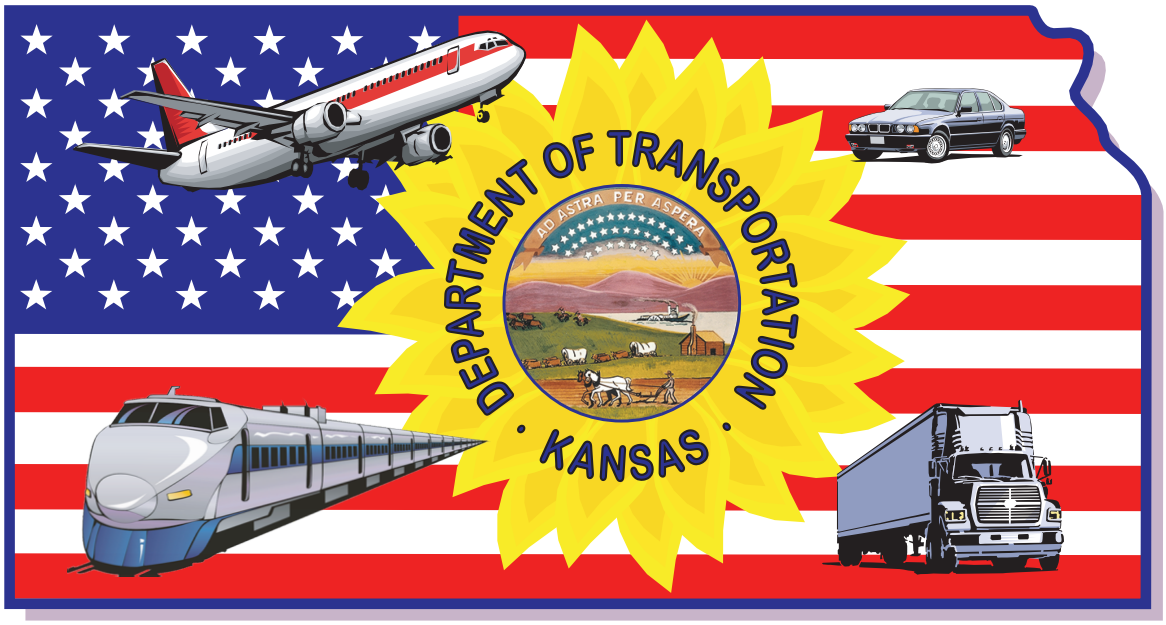
Table A3: TSRST Data

US-59 2" Surface Recycle TSRST Data					
Specimen Number	With or Without ARA	Failure Temperature	Transition Temperature	Fracture Stress	Slope of Stress Curve
		ºC	ºC	psi	
417	w	-26.6	-21.0	434	28.1
418	w/o	-22.2	-10.7	387	21.1
419	w/o	-19.9	-12.8	429	26.2
420	w	-24.8	-20.5	448	32.8
421	w/o	-20.5	-13.5	456	28.9
Average w =		-25.7	-20.8	441.0	30.5
Average w/o =		-20.9	-12.3	424.0	25.4

Table A4: GTM Data

Station	Mix Type	Rev.'s	GSI
44 + 50 SBL	W/O	30	1.04
		45	1.09
		60	1.14
		90	1.20
		*121	1.29
44 + 50 SBL	W/ ARA-1P	30	1.33
		45	1.51
250 + 00 SBL	W/O	30	1.00
		45	1.00
		60	1.00
		90	1.02
		*122	1.04
250 + 00 SBL	W/ ARA-1P	30	1.16
		45	1.28
		60	1.36
		90	1.52
350 + 00 SBL	W/ ARA-1P	30	1.16
		45	1.28
		60	1.38
540+00 SBL	W/O	30	1.00
		45	1.01
		60	1.01
		90	1.04
		*130	1.07
540+00 SBL	W/ARA-1P	30	1.07
		45	1.19
		60	1.30
560+00 SBL	W/O	30	1.00
		45	1.00
		60	1.01
		90	1.02
		*149	1.04
560+00 SBL	W/ARA-1P	30	1.06
		45	1.11
		60	1.18

* Sample was taken to equilibrium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