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US-69 SURFACE TEXTURE AND NOISE STUDY

(4.7 mi N SCoL, N to 0.6 mi S K-68, Miami County)

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16 Abstract

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The surface textures investigated in this study are Astroturf drag, Carpet Drag, Longitudinal tining, and Grinding sections with groove widths of 0.110", 0.120", and 0.130". In addition to these surface textures the effects of single saw-cut joints vs. normal saw-cut joints and changing the effective wheelbase of the 0.130" grinding sections were also investigated.

Tests were performed in each section to evaluate the sections performance in Sound, Friction and Surface Profile. The Sound tests consisted of a Close Proximity Test and a Pass-by Test. The Friction tests consisted of the Skid Test and Sand Patch Test. The Surface Profile tests consisted of a South Dakota Profilometer, a Model 6000 lightweight profilometer, and a California type profilograph.

The results from the Pass-by test with a truck indicated that the engine noise was the dominant component of noise emitted from a roadway when the grade is uphill. These uphill sections had the highest noise levels and the surface texture had little impact. The results from the Pass-by test with a car were all within 3.0 dBa. In the results from the Close Proximity test with a car the longitudinal section was 4.2 dBa greater than the noise from the grinding sections. This indicates that the additional engine noise that is measured in the Pass-by test negates some of the effects of surface texture on lowering the sound level.

The test sections were ranked based on the results of the tests and the grinding sections with 0.120" groove spacing performed the best. The longitudinal tining sections were ranked the lowest.

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Final Report

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ABSTRACT

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ACKNOWLEDGEMENTS

Contributors to the Study included Ideker, Inc., Highway Services, Ames Engineering, The Transtech Center for Pavement Surface Characteristics, and Kansas Department of Transportation's (KDOT) District One, Environmental Services, and Materials and Research.

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INTRODUCTION

The noise generated from roadways is a growing concern for the paving industry. As roadways are reconstructed and rehabilitated in urban cities, citizens are concerned with the sound level generated by traffic on the roadway. The major source of vehicle noise is a combination of the noises produced by the engine, exhaust, and tires. Research has indicated that different texturing methods will reduce the tire/pavement interface sound levels and thus reduce the noise from the roadway. For this investigation a test site was selected and several different surface textures for concrete pavement will be evaluated to determine the effect of surface texture on the sound levels emitted from the roadway. Ride and safety issues will also be evaluated to determine the overall effects of the different surface textures.

A major modification project that was under construction during 2004 was selected as the test site for the surface texture study. The project was located on US-69 in Miami County from 4.7 miles north of the county line, north to 0.6 miles south of K-68. The project consisted of the reconstruction of a two lane highway into a four lane highway. The two southbound lanes were constructed during 2003, and the existing lanes were reconstructed in 2004. The test sections consist of 10.0” PCCP (NRDJ) over 4.0” CTB over 6.0” LTSG and are located in the northbound lanes.

There were thirteen test sections selected and each section had a length of 984 feet. The textures included longitudinal tining, grinding with different saw blade spacing, carpet drag, and Astroturf drag. The saw blade spacing for the grinding sections resulted in groove widths of 0.110”, 0.120”, and 0.130”. These sections will be referred to as the 110, 120 and 130 grinding sections. The 130 grinding sections were completed with jacks and without jacks to determine the effect of changing the effective wheelbase. The sections with jacks had an effective

wheelbase of 12’ and the sections without jacks had an effective wheelbase of 4’. For each texture section there was initially a section with normal saw cut joints and a section with single saw cut joints. There was a miscommunication with the saw crew during construction which resulted in both 110 grinding sections receiving normal saw joints and both 120 grinding sections receiving single saw joints. The following table describes the 13 test sections.

TEXTURE PLAN

Test Section	Stationing (metric)	Texture	Joint Type	Operation	Groove Width (in)
1	19+365 – 19+665	Astroturf Drag	Single Saw		
2	22+500 – 22+800	Grinding	Normal	No Jacks	0.110
3	22+800 – 23+100	Grinding	Normal	No Jacks	0.110
4	23+100 – 23+400	Grinding	Single Saw	No Jacks	0.120
5	23+600 – 23+900	Grinding	Single Saw	No Jacks	0.120
6	23+900 – 24+200	Grinding	Normal	Jacks	0.130
7	24+200 – 24+500	Grinding	Single Saw	Jacks	0.130
8	24+500 – 24+800	Grinding	Normal	No Jacks	0.130
9	24+800 – 25+100	Grinding	Single Saw	No Jacks	0.130
10	25+400 – 25+700	Longitudinal Tining	Normal		
11	25+700 – 26+000	Longitudinal Tining	Single Saw		
12	26+000 – 26+300	Carpet Drag	Normal		
13	26+300 – 26+600	Carpet Drag	Single Saw		

At each test section there were several tests performed. These tests evaluated the performance of the pavement in the following three categories: friction, sound and surface profile. The test methods and results are discussed in the following sections.

FRICTION

There were two friction tests performed at all of the sections. They included the Skid Test and the Sand Patch Test. Both tests were performed in the northbound driving lanes. The Sand Patch Test measured the pavement macrotexture depth using a volumetric technique. This test

method was performed in accordance with ASTM E965. From the results of the test the average macrotexture depth (MTD) was calculated. The test was performed four times in each section and the average MTD is reported in the following table.

The T1290 Friction Tester was used to perform the Skid Test at each test section. This test measured the average locked wheel (skid) friction characteristics at each test section. The test was performed five times in each test section and the average friction number is reported in the following table.

Test Section	Texture	ASTM E965 Results AVG MTD (in)	T1290 Friction Tester Results AVG FN
1	AT-SS	0.019	47.6
2	110-N-EW-12'	0.032	50.8
3	110-N-EW-12'	0.041	49.7
4	120-SS-EW-12'	0.042	52.1
5	120-SS-EW-12'	0.045	51.5
6	130-N-EW-4'	0.052	60.7
7	130-SS-EW-4'	0.057	57.1
8	130-N-EW-12'	0.052	56.4
9	130-SS-EW-12'	0.051	55.1
10	LT-N	0.024	59.0
11	LT-SS	0.022	50.8
12	CD-N	0.011	46.6
13	CD-SS	0.014	53.0

All of the test sections have acceptable Friction numbers. (Acceptable Friction numbers are > 30) The Astroturf, longitudinal tining, and carpet drag sections were below the acceptable Mean Textured depth value of 0.032" though these sections had acceptable friction results. As expected the carpet drag sections and Astroturf section have the lowest MTD values at an

average of 0.015” and the lowest friction numbers at an average of 49.0. The 130 grinding section had the highest MTD values at an average of 0.053” and an average friction number of 57.3.

SOUND

There were two sound measurements obtained from each test section. A Pass-by test and a Close Proximity test were performed to obtain sound levels generated by the roadway. The Pass-by test measured the noise generated by the tire/pavement interface and from the vehicle. The Pass-by test results were obtained with a Larson Davis – Model 720 Type 2 Sound Level Meter. This test was performed at the edge of the pavement shoulder and readings were obtained for the Transtec SI vehicle and a ten wheel dump truck. The Sound Level Meter was approximately 12.8’ from the right wheel path where the car and truck were traveling in the northbound driving lane. A difference in three feet from the vehicle drifting in the lane would result in approximately 0.5 dBa difference in the sound level measured. The sound results from the car had a standard deviation of 0.5 dBa, and the sound results from the truck had a standard deviation of 1.0 dBa. The larger deviation in the truck can be attributed to the engine noise in addition to the drifting of the truck. Both vehicles were driving at a speed of 60 mph and two passes were recorded.

A Close Proximity test was performed by the Transtec Center for Pavement Surface Characteristics. The Close Proximity method measured the sound levels using the TCPSC SI equipment. In this test two microphones were located close to the tire and isolate the tire/pavement interface noise. The diagram below, Figure 1, illustrates the position of the microphones. The Close Proximity test was performed on the Transtec SI car traveling at 60

mph. This test was performed four times; two times with the leading edge configuration and two times with the trailing edge configurations. This test was performed in the right wheel path in the northbound driving lane. The drifting of the vehicle had little effect on the sound results as the microphone is attached to the car and the distance between the tire/pavement interface and the microphone remains constant. The average of the four measurements is listed in the following table.

The Pass-by tests measured the sound pressure at a point as the vehicle passed by. The Close Proximity test measured the sound intensity, which represents the energy passing through a unit area. The sound intensity was measured by multiplying the sound pressure by the acoustic particle velocity between the two microphones. Both test results have the same units and research indicates that the values correlate well between the two tests.

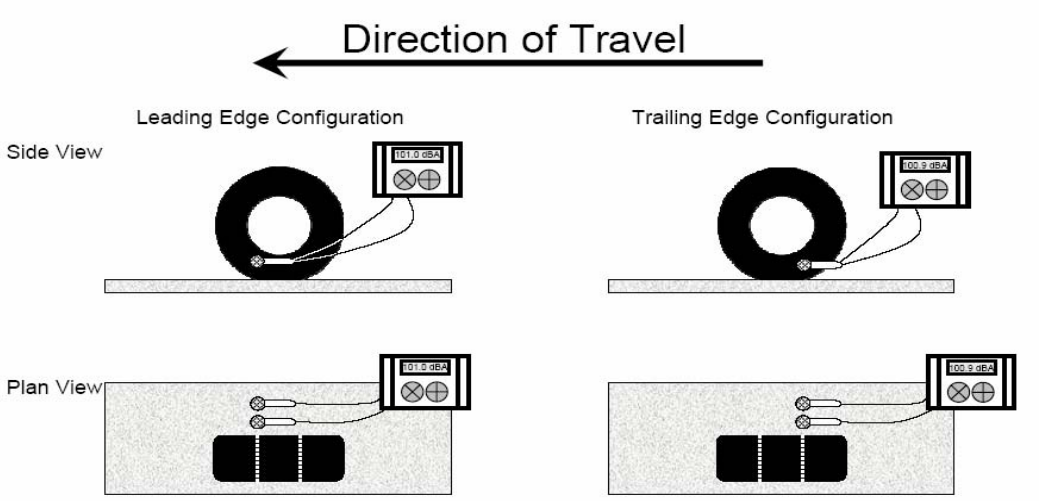

FIGURE 1

(Diagram provided by The Transtec Center for Pavement Surface Characteristics)

Test Section	Texture	PASS-BY TEST RESULTS Car Lmax (dBa)	Truck Lmax (dBa)	CLOSE PROXIMITY TEST RESULTS Car SI (dBa)
1	AT-SS	85.5	95.2	103.7
2	110-N-EW-12'	86.1	95.5	102.6
3	110-N-EW-12'	86.4	93.4	103.3
4	120-SS-EW-12'	85.9	94.3	103.4
5	120-SS-EW-12'	86.2	95.3	103.5
6	130-N-EW-4'	86.5	93.3	105.1
7	130-SS-EW-4'	86.3	94.9	105.2
8	130-N-EW-12'	87.3	95.5	105.0
9	130-SS-EW-12'	86.4	92.7	104.2
10	LT-N	88.9	95.1	106.1
11	LT-SS	86.7	96.2	108.2
12	CD-N	86.1	98.5	104.1
13	CD-SS	85.1	97.2	103.2

There was only a 3.8 dBa difference between the lowest and highest sound levels from the Pass-by test with the car. A 3 dBa difference in sound is the smallest perceptible difference that a human ear can hear and is barely discernable. The highest noise levels were obtained at the pavement section with longitudinal tining and the lowest noise levels were obtained at the pavement section with carpet drag and Astroturf drag sections. In Figure 2 the average sound level for each texture type is displayed from the lowest sound level to the highest sound level. The Astroturf section had the lowest sound level at 85.5 dBa and the longitudinal tining section had the highest sound level at 87.8 dBa. This is only a difference of 2.3 dBa between the lowest and highest sound level which is barely discernable to the human ear.

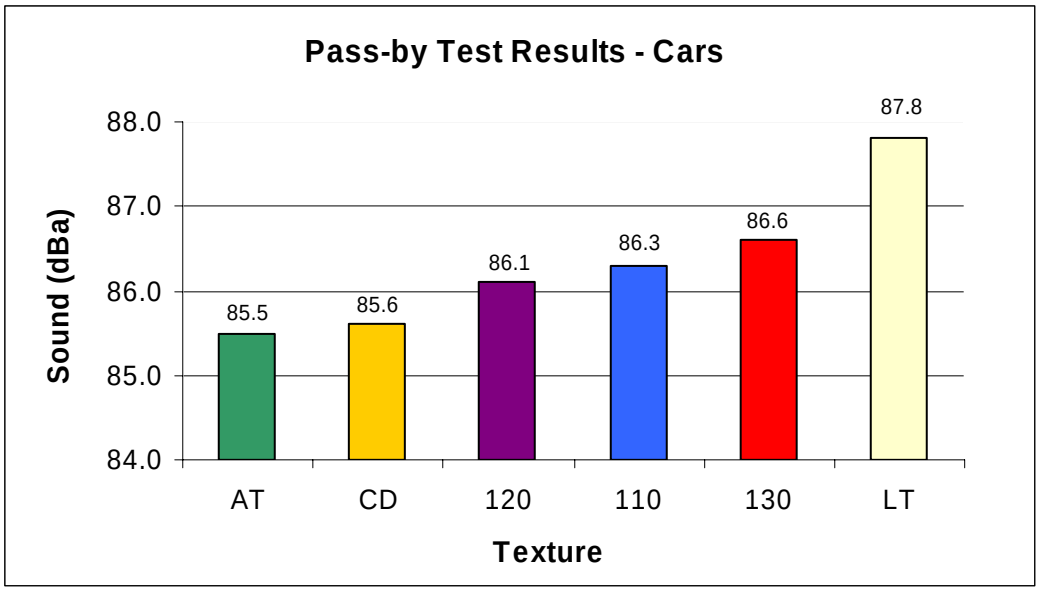

FIGURE 2

The average sound level from each texture section is displayed from the lowest sound level to the highest sound level for the Pass-by test with a truck in Figure 3. The 130 grinding sections had the lowest sound level at 94.1 dBa and the carpet drag sections had the highest sound levels at an average of 97.9 dBa. This does not correlate with the results of the Pass-by test with a car, as the carpet drag section had the second lowest sound level. After analyzing the disparity it was determined that the highest sound levels were from the test sections with uphill grades. The two carpet drag sections were on uphill grades and these two sections have the highest noise level at an average of 97.9 dBa. The Astrotruf test section had the lowest noise level of 92.7 dBa and was on a downhill grade. The truck engine worked harder to maintain the truck at 60 mph on the uphill grades thus creating more noise. The average sound level on the test sections with a flat or downhill grade was 94.5 dBa, and tests sections with an uphill grade averaged 97.3 dBa.

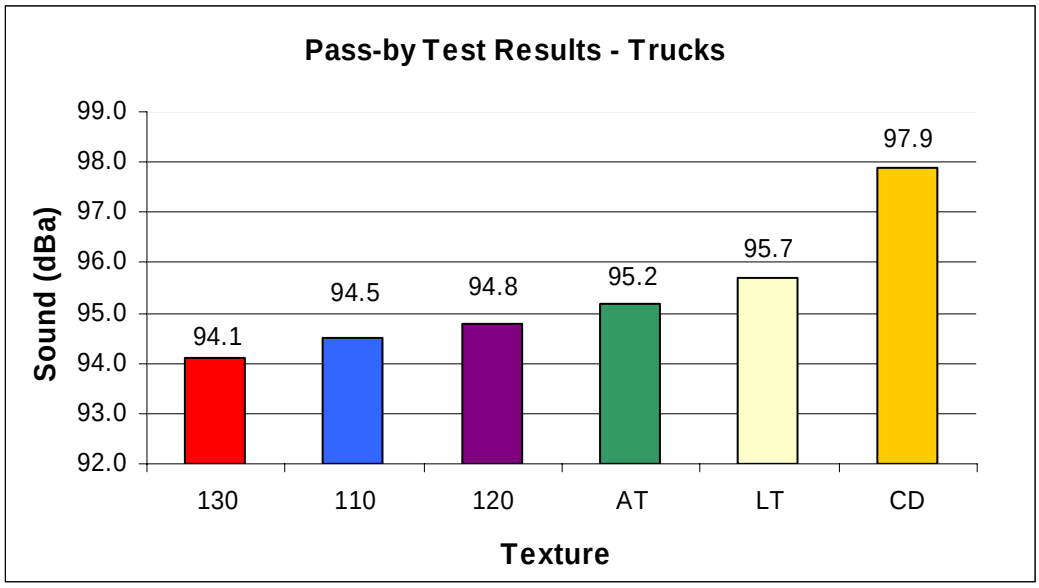

FIGURE 3

In the sound intensity results the highest sound levels were from the longitudinal tining test sections with a SI average of 107.2 dBa. The lowest level of sound was the 110 grinding test section with a SI average of 103.0 dBa. The average sound level for the longitudinal tining section is greater then 3.0 dBa higher from all of the test sections except the 130 grinding section. This difference of greater then 3.0 dBa would be noticeable to the human ear. In Figure 4 the results of the Close Proximity test for each texture are displayed.

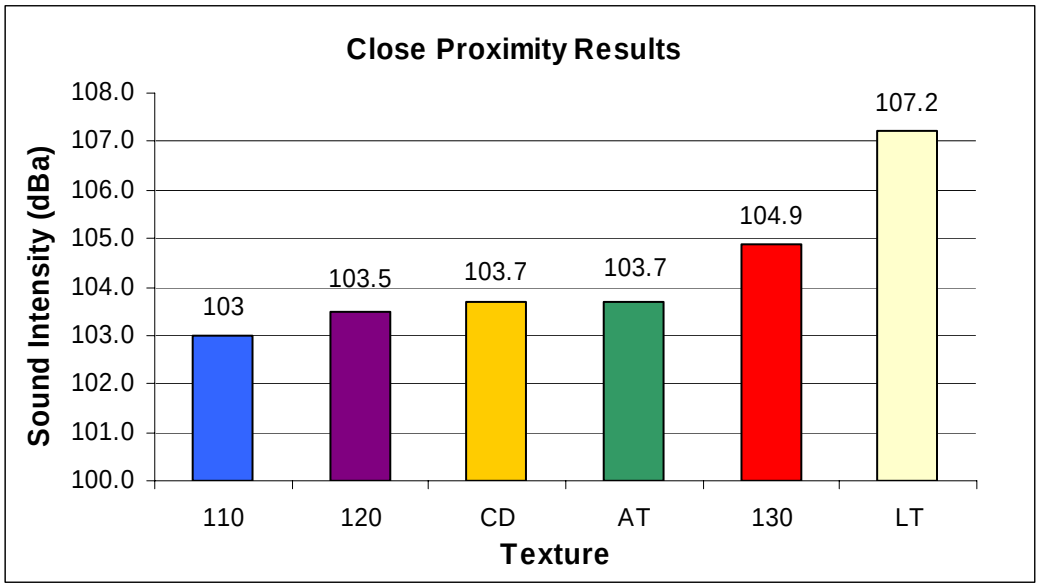

FIGURE 4

The results between the Pass-by and Close Proximity tests with a car were similar for all of the test sections. In both tests the carpet drag, Astroturf, and the 110 and 120 grinding sections had the lowest sound levels and were all within 0.8 dBa in each individual test. The two highest test sections in both tests were the 130 grinding sections and the longitudinal tining sections. In the Close Proximity test the 130 grinding section was 1.9 dBa higher and the longitudinal tining section was 4.2 dBa higher then the lowest sound levels. In the Pass-by test the 130 grinding section was 1.1 dBa higher and the longitudinal sections were 2.3 dBa higher then the lowest sound levels. The Close Proximity results and the Pass-by with a car results are listed in Figure 5.

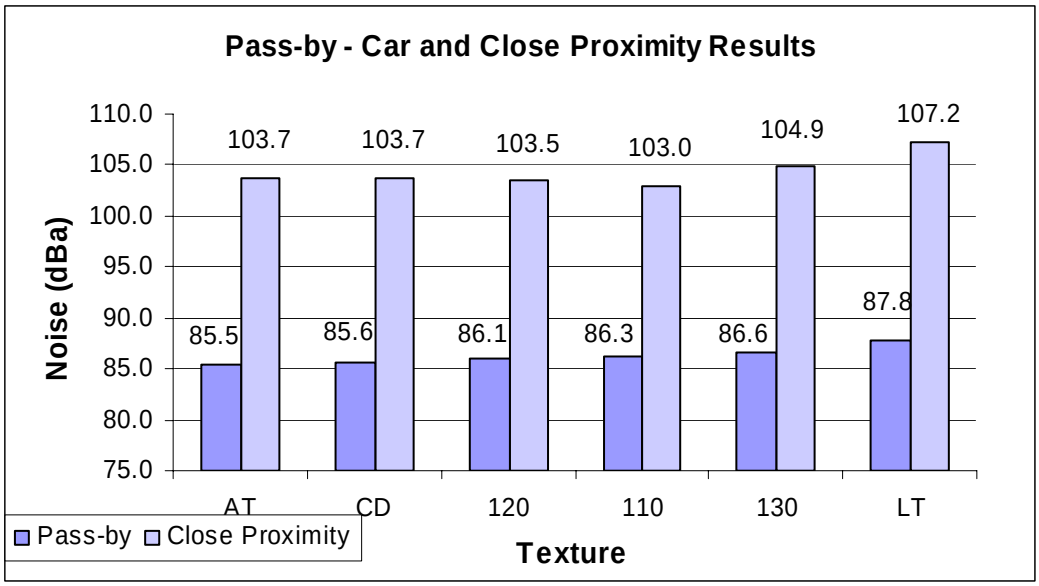

FIGURE 5

The longitudinal tining sections produced the highest sound levels from a car and the sound level can be reduced by using a different texturing method. The Astroturf, carpet drag, 110 and 120 grinding sections all produced lower sound levels and are within 0.8 dBa, which is not discernable by the human ear. In the results from the Close Proximity test there was a greater difference between the lowest sound levels and the highest sound levels than in the results from the Pass-by test with a car. The Pass-by test measured the engine noise in addition to the tire/pavement interface noise, which indicates that the engine noise is the dominant component in the pavement noise emitted from the roadway and lessens the effects that surface texture has on lowering the sound levels. The Pass-by results from the truck were dependant on the grade of the roadway thus the effect of surface texture on the sound levels emitted from a truck could not be determined.

SURFACE PROFILE

There were three surface profile tests performed on the test sections. They included a South Dakota profilometer, a Model 6000 lightweight profilometer, and a California type profilograph. The South Dakota profilometer utilized a single point laser system to measure the IRI value of the test sections. The lightweight profilometer utilized a new TriODS laser system, which is a multipoint laser system to measure the IRI value of the test sections. This testing was provided by Ames Engineering. Both tests were performed in the right wheel path in the northbound driving lane. The results of the various tests are is in the following table.

		PROFILOMETER RESULTS		**PROFILOGRAPH**
Test Section	**Texture**	**S.D. Prof. IRI (in/mi)**	**Lightweight Prof. IRI (in/mi)**	**PRI (in/mi)**
1	AT-SS	88.5	109.0	30.2
2	110-N-EW-12'	75.5	47.3	10.4
3	110-N-EW-12'	77.4	46.0	7.4
4	120-SS-EW-12'	74.9	37.6	7.1
5	120-SS-EW-12'	83.5	37.2	5.6
6	130-N-EW-4'	99.8	43.9	12.1
7	130-SS-EW-4'	102.1	40.1	13.3
8	130-N-EW-12'	88.7	37.4	8.5
9	130-SS-EW-12'	94.8	44.2	11.4
10	LT-N	91.4	89.3	24.0
11	LT-SS	101.1	102.6	29.8
12	CD-N	109.3	107.3	32.6
13	CD-SS	91.3	114.5	28.7

In the table below the average IRI and PRI is listed for each surface texture.

	PROFILOMETER RESULTS		**PROFILOGRAPH**
Texture	**S.D. Prof. IRI (in/mi)**	**Lightweight Prof. IRI (in/mi)**	**PRI (in/mi)**
Astroturf	88.5	109.0	30.2
Grinding – 110	76.4	46.7	8.9
Grinding – 120	79.2	37.4	6.4
Grinding – 130	96.3	40.9	11.3
Longitudinal Tining	96.2	96.0	26.9
Carpet Drag	100.3	110.9	30.7

The results from the South Dakota profilometer indicate that the 110 and 120 grinding sections are the smoothest sections with average IRI values of 76.4 in/mi and 79.2 in/mi respectively. The roughest test sections were the carpet drag section with an average IRI value of 100.3 in/mi. The 130 grinding section was the second roughest section with an IRI of 96.3 and was rougher then the longitudinal tining section. The single saw cut sections were rougher than the normal saw cut sections in all of the test sections except the carpet drag test sections. The effective wheelbase of 4' resulted in a rougher ride than the effective wheelbase of 12'.

The results from the lightweight profilometer indicate that the 110, 120 and 130 grinding sections were the smoothest with average IRI values of 46.7 in/mi, 37.4 in/mi, and 40.9 in/mi. The IRI values for the carpet drag, Astroturf and longitudinal tining sections were much higher with IRI values that were greater than two times the IRI values for the grinding sections. The single saw cut sections were rougher than the normal saw cut sections in all of the test sections except the 130 grinding section with an effective wheelbase of 4'. The effect of changing the effective wheelbase was varied as the 12' effective wheelbase had the roughest and smoothest section.

The profilograph results indicate that the 110, 120 and 130 grinding sections were the smoothest. The carpet drag and Astroturf sections would require corrective actions as their profile indexes are outside of the allowed range of 30.1 in/mi required by KDOT Special Provision *Portland Cement Concrete Pavement (Pavement Smoothness)* 90P-111-R10.

The results were similar between the two profilometers for the longitudinal tining and carpet drag sections. The IRI values for the grinding sections were very different between the two profilometers. The 130 grinding section had the second highest IRI according to the South Dakota profilometer and had the second lowest IRI according to the lightweight profilometer. This may be explained by the single point laser jumping in and out of the grooves caused by the

grinding operation, whereas the multipoint laser system has a wider footprint and thus will not jump in and out of the grooves resulting in a smoother IRI. This is noticeable in all of the grinding sections where the IRI value from the multi-point system is less than half the IRI value from the single point laser system. The results from the profilograph agree with the lightweight profilometer in that all three grinding sections are significantly smoother then the non-grinding sections.

SMOOTHNESS vs. SOUND

The results between the profile tests and the sound tests were compared to see if there was a correlation between the smoothness of the roadway and the sound emitted.

In the comparison between the sound test results and the South Dakota profilometer there was no correlation between smoothness and sound. The carpet drag section was the roughest section and had the second lowest sound level in the Pass-by test results and the third lowest sound level results in the Close Proximity test. The 110 grinding section was the smoothest section and had the fourth lowest sound level in the Pass-by results and the lowest sound level in the Close Proximity results. In Figures 6 and 7 the South Dakota profilometer results are listed from smoothest to roughest. The Pass-by sound results are listed in Figure 6 and the Close Proximity sound results are listed in Figure 7.

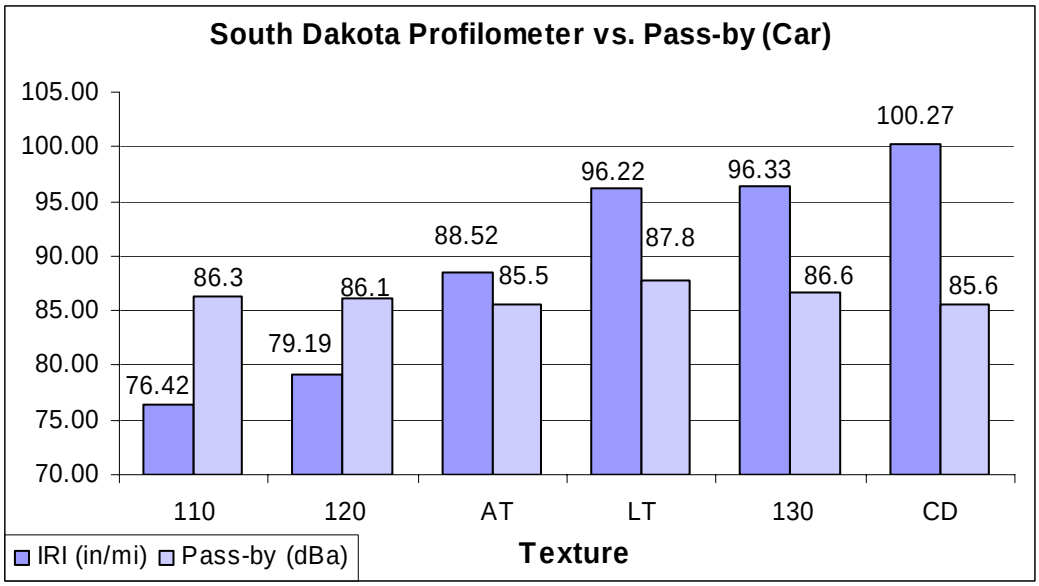

FIGURE 6

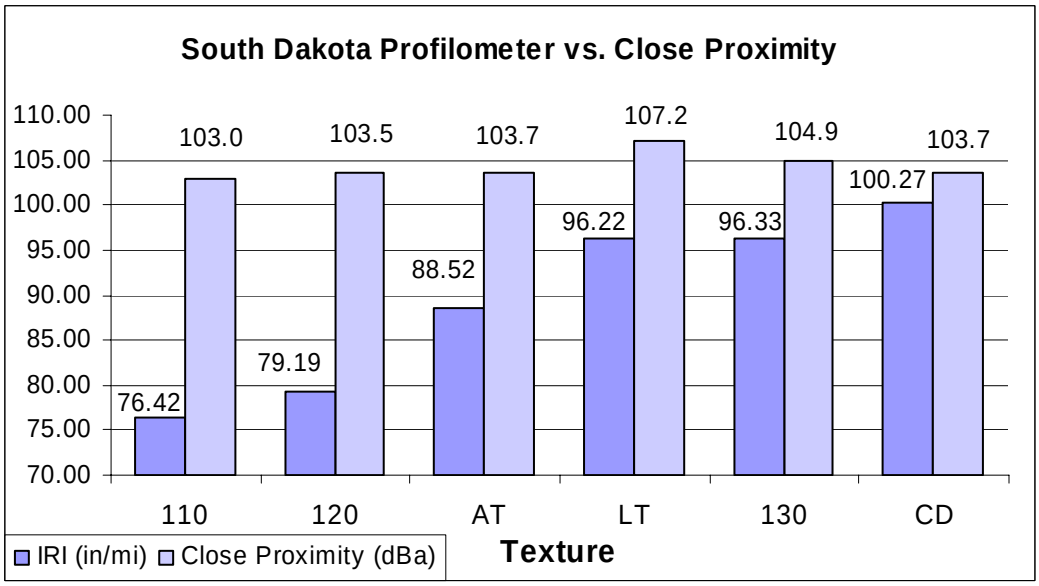

FIGURE 7

In the comparison between the lightweight profilometer results and the sound results there was no correlation between smoothness and sound. The 120 grinding section was the smoothest section and had the third lowest sound level in the Pass-by test results and had the second lowest sound level in the Close Proximity results. Again the carpet drag sections were the roughest section and had the second lowest sound level in the Pass-by test results and the

third lowest sound level results in the Close Proximity test. Figures 8 and 9 illustrate the South Dakota profilometer results from smoothest to roughest. The Pass-by results are listed in Figure 8 and the Close Proximity results are listed in Figure 9.

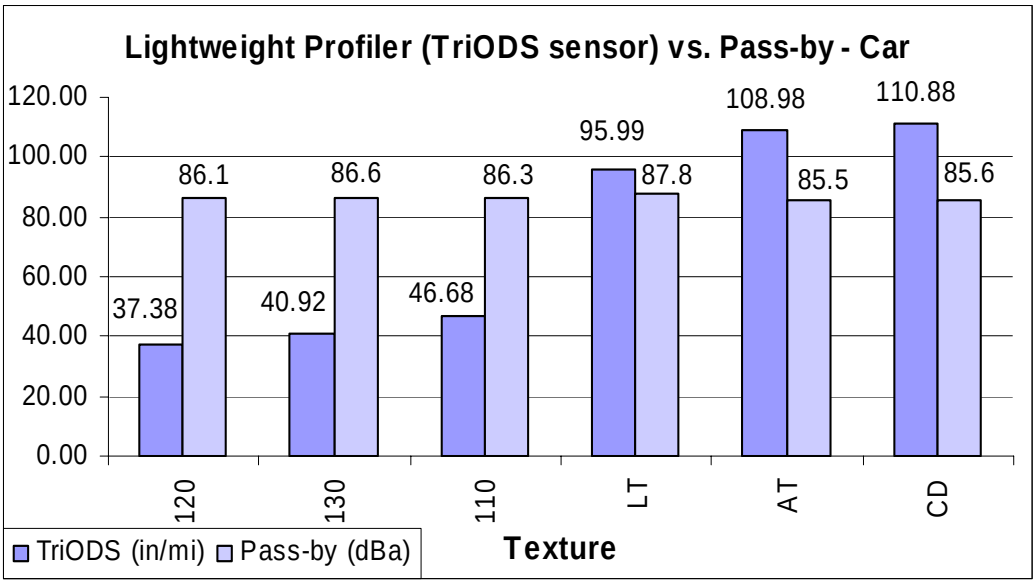

FIGURE 8

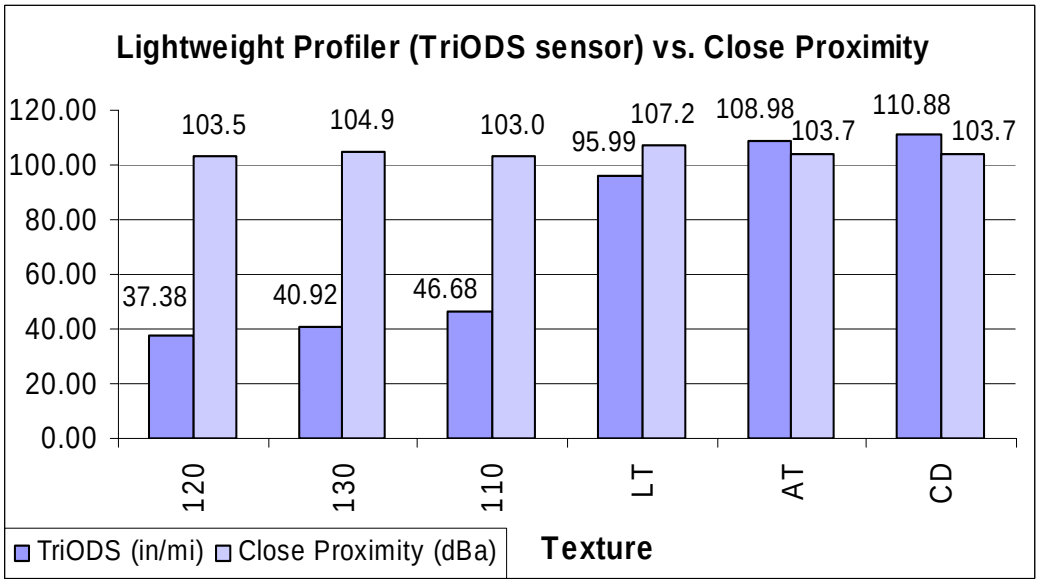

FIGURE 9

The PRI values from the profilograph were also compared to the sound test results. The smoothest section from the profilograph results was the 120 grinding section with a PRI value of

6.57 in/mi and the roughest section was the carpet drag section with a PRI value of 31.9 in/mi. In the comparison with the Pass-by test results the 120 grinding section had the third lowest sound level and the carpet drag section had the second lowest sound level. In the comparison with the Close Proximity test the 120 grinding section had the lowest sound level and the carpet drag was the second lowest sound level at only 0.2 dBa higher than the 120 grinding section.

From analyzing the data there is no correlation between roughness and noise emitted from the roadway within this range of roughness values. In all of the comparisons between the smoothest and roughest section the largest difference was 0.7 dBa. Therefore the roughness of the roadway has little impact on the noise level within this range of roughness values.

FRICTION vs. SOUND

The results between the friction tests and the sound tests were compared to see if there was a correlation. In the charts below the friction tests are plotted with the results from the sound tests.

In Figure 10 and 11 the friction number is listed from lowest friction to highest friction. In Figure 10 the friction numbers are presented along with the results from the Pass-by car test. The Astroturf section has the lowest friction number and the lowest noise level. The 130 grinding section has the highest friction number and the second highest noise level.

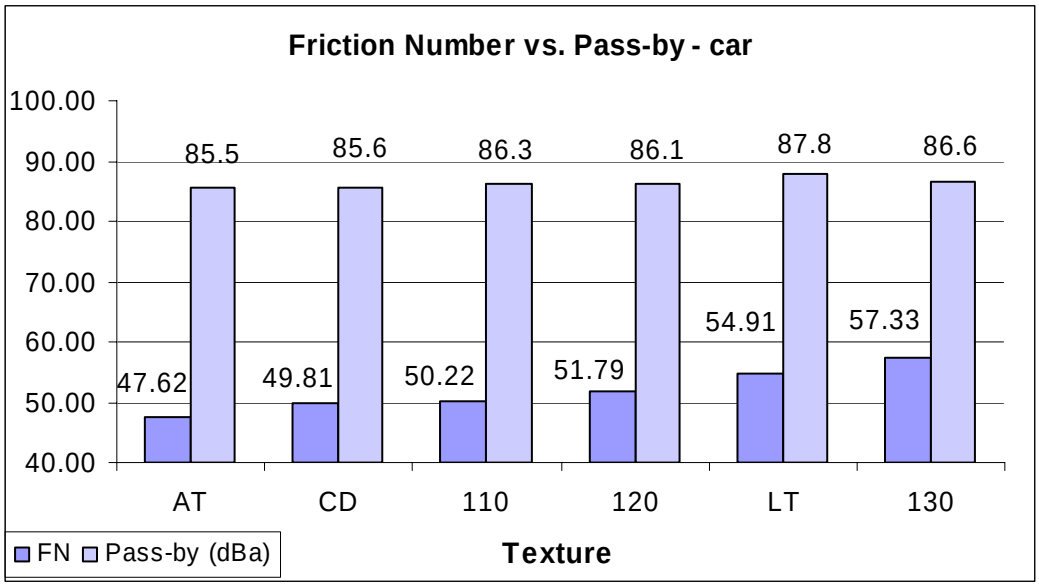

FIGURE 10

In Figure 11 the friction numbers were listed from the lowest to the highest and the results from the Close Proximity test are also presented. The lowest noise level was associated with the 110 grinding section which had the fourth highest friction number. The highest noise level was associated with the longitudinal tining section which had the second highest friction number.

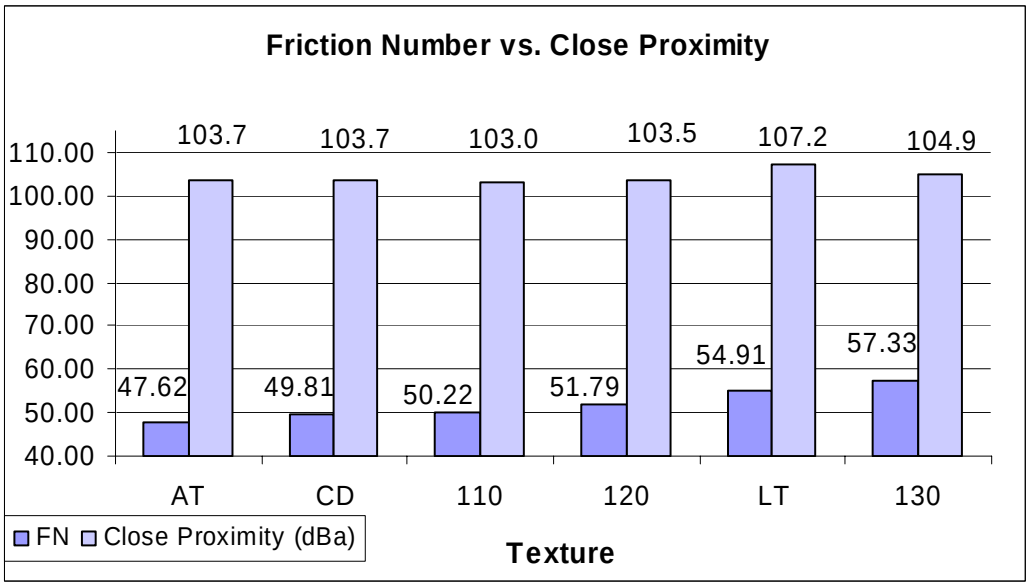

FIGURE 11

The sound tests were also compared with the results from the sand patch test. The three sections; carpet drag, Astroturf, and longitudinal tining, had the lowest mean texture depth value at an average of 0.018 in and the three grinding sections had an average mean texture depth of 0.045 in. This does not correlate with the sound as the longitudinal tining has the highest sound level and has a low MTD value, and the Astroturf and carpet drag section have two of the lowest sound levels and also have low MTD values.

From these results it is determined that the MTD and friction numbers have no correlation with the sound levels.

SINGLE SAW vs. NORMAL SAW CUT

In the longitudinal tining, carpet drag, Astroturf and 130 grinding test sections, each texture had separate sections with normal and single saw cut joints. The normal saw cuts were made according to KDOT standards and resulted in a 3/8" saw cut. The single saw cuts resulted in a 1/8" saw cut. The joints were sealed before the tests were performed. An additional cut was made in the single saw cut sections which resulted in a 1/4" saw cut to allow for the hot type joint sealing compound to be inserted. The normal saw cut joints were expected to result in a higher noise level due to the wider joint on a smooth pavement.

The impact of the joint type on the sound level is minimal. In the Pass-by results the single saw joint sections had lower decibel levels, and the greatest difference was 2.2 decibels in the LT section. The other sections were within 1.0 dBa. From the Close Proximity tests there were varied results as the single saw sections had higher sound levels in the longitudinal test section and the 130 grinding section with an effective wheelbase of 4 foot. The results from these sections are in Figure 12 and 13.

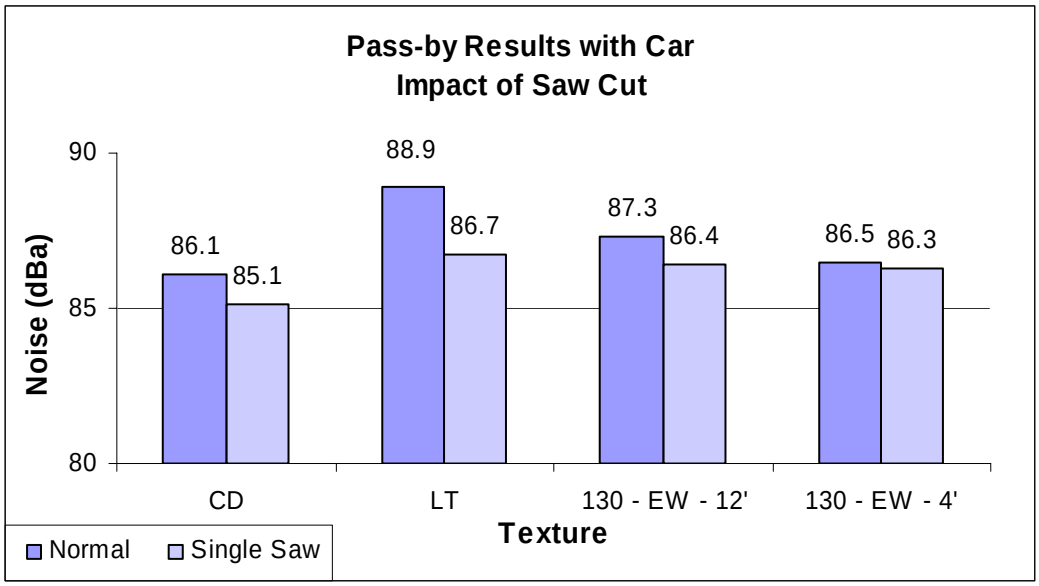

FIGURE 12

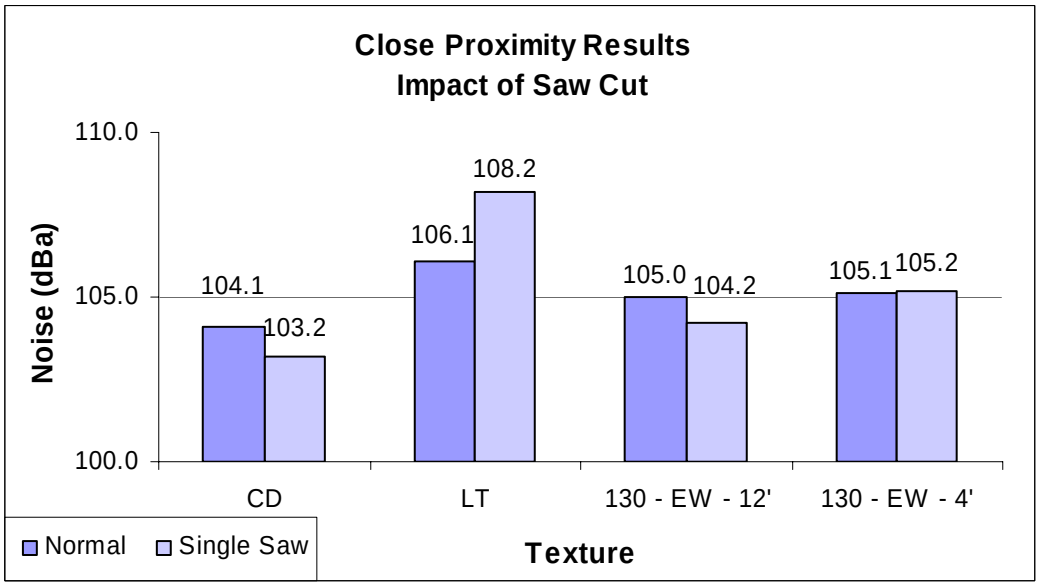

FIGURE 13

EFFECTIVE WHEELBASE

At the 130 grinding sections the effective wheelbase was changed to determine the effect on the sound emitted by the roadway. The sections used a normal effective wheelbase of 12' and an adjusted effective wheelbase of 4'. The sections with an effective wheelbase of 4' would result

in the grinder having a floating head. This would follow the profile of the road more closely and result in a rougher ride. The floating head would also result in a more uniform texture as it follows the profile of the pavement closer.

The impact of the effective wheelbase on the sound level is minimal. The sound levels from these sections were similar and the greatest difference was 1.0 dBa. The sections with a 4' effective wheelbase had lower sound levels in the Pass-by sound test, but had higher sound levels in the Close Proximity sound test.

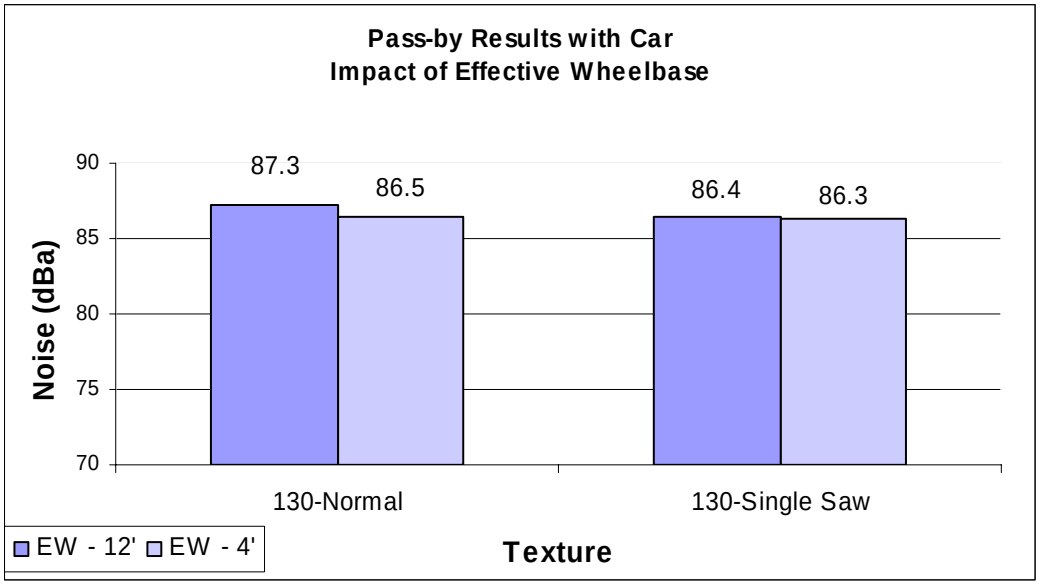

FIGURE 14

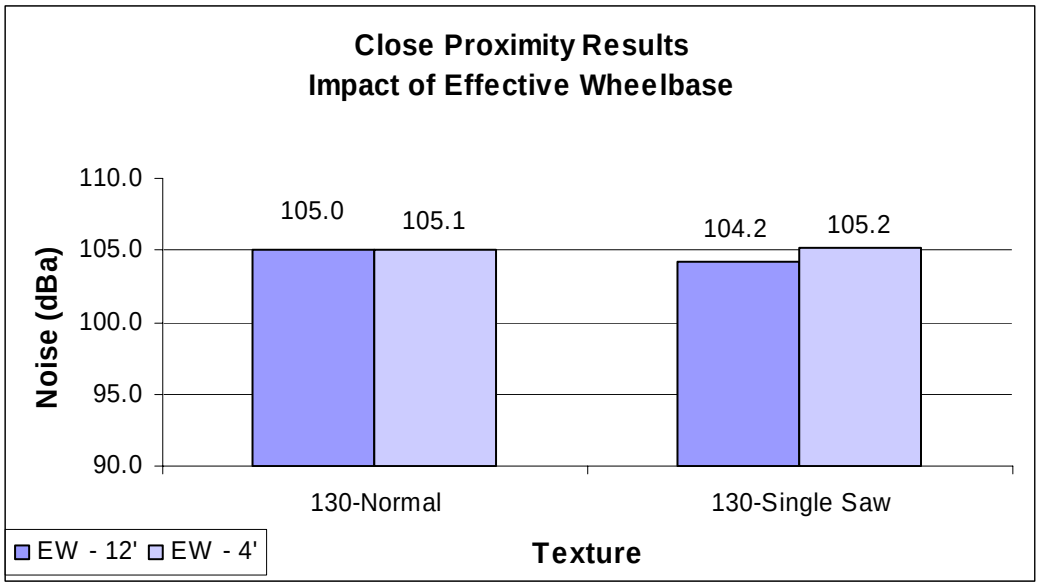

FIGURE 15

TEST SECTION RANKINGS

After all of the tests were completed the sections were ranked in each of the three pavement evaluation categories, friction, sound, and surface profile. Each evaluation category was weighted equally and the rankings appear in the following table. The grinding sections had the highest rankings with all eight sections receiving the top 8 rankings. The 110 grinding sections performed the best and had the highest ranking. The normal KDOT section that consists of longitudinal tining was ranked very low with a ranking of 11 and 13.

	Section	Rankings			Overall Rankings
		Texture	Sound	Profile	
1	AT-SS	12	4	10	10
2	110-SS-EW-12'	10	2	5	4
3	110-SS-EW-12'	8	5	4	4
4	120-N-EW-12'	6	3	1	1
5	120-N-EW-12'	7	7	2	2
6	130-N-EW-4'	1	10	7	6
7	130-SS-EW-4'	2	9	8	8
8	130-N-EW-12'	2	11	3	2
9	130-SS-EW-12'	4	8	6	6
10	LT-N	5	13	9	11
11	LT-SS	11	12	12	13
12	CD-N	13	6	13	12
13	CD-SS	9	1	11	9

CONCLUSIONS

This investigation was performed to determine the effect of surface texture on the sound emitted from a concrete pavement. Thirteen test sections were selected with six different surface textures. In each section tests were performed to evaluate the section's performance in three pavement evaluation categories; sound, friction, and surface profile.

A Close Proximity test was performed with the Transtech SI car and Pass-by tests were performed with the Transtech SI car and a ten wheel dump truck. After analyzing the results of the Pass-by test with a truck the sound was dependant on the grade of the roadway and therefore the impact of the texture could not be determined. After analyzing the sound results from the Pass-by test with a car and the close proximity test the longitudinal tining sections have the highest sound levels. In the Pass-by test the longitudinal tining section was within 3.0 dBa of the

other sections and in the Close Proximity test the longitudinal section was greater then 3.0 dBa higher than the other sections. The other sections were very similar and were all within 2.0 dBa.

At each test section the Sand Patch Test and the Skid test were performed. The results from the Skid test met KDOT standards for all of the test sections. The Astroturf, longitudinal tining, and carpet drag sections were below the acceptable Mean Textured depth value though these sections had acceptable friction results. These results were compared with the sound results and there was no correlation.

Also at each test section surface profile tests were performed with the South Dakota profilometer, lightweight profilometer and a California profilograph. The grinding sections were the smoothest sections and the carpet drag sections were the roughest. The carpet drag and Astroturf sections would not meet current smoothness specifications. In comparing the results of the profile tests with the sound tests there was no correlation between smoothness and noise level.

The test sections were ranked for their performance in the three performance categories and the grinding sections were ranked the highest. The 120 grinding sections received the top two rankings. The current KDOT standard longitudinal tining sections received the lowest rankings. The maximum reduction in the noise level from the longitudinal tining section to the grinding sections was 4.2 dBa from the Close Proximity test. In the Pass-by test the longitudinal tining sections were within 3.0 dBa. There is a significant difference in the longitudinal section and the other test sections in the Close Proximity test that was not represented in the Pass-by test. This indicates that the additional engine noise that is measured in the Pass-by test negates some of the effects of surface texture on lowering the sound level. The test sections were all within 3.0 dBa in the Pass-by with a car test and thus all of the textures would produce a similar noise level.

A difference of greater then 3.0 dBa in the Pass-by test would warrant the change of surface texture to reduce pavement noise levels.

The test sections will continue to be monitored to study the effects of traffic and time on the texture and sound levels produced.