OBSI testing of the I-70 Surface Texture Test sections was conducted on May 21, 2010. The results indicated the NGCS texture is the quietest at 100.9 dBA and the exposed aggregate the loudest at 104.5 dBA. The rank order of the sections from quietest to loudest was NGCS, longitudinally grooved drag texture, drag texture, conventional diamond grinding, longitudinal tined, and exposed aggregate. All textures have increased in level since their construction in 2008 with the NGCS indicating the greatest increase.
Introduction

In the fall of 2008, the Kansas Department of Transportation in cooperation with the Federal Highway Administration and the National Concrete Pavement Technology Center, constructed a two-lift concrete pavement on I-70 near Abilene, Kansas. This project was to demonstrate the two lift construction technique in the US as this practice is more prevalent in Europe. The two lift construction technique allows a thicker bottom layer to be constructed with a more economical aggregate while using higher quality aggregates in the thinner upper lift. In addition to the two lift construction, the DOT also constructed seven surface texture experiments as indicated in Figure 1.

On May 21, 2010 the ACPA conducted OBSI testing of the test sites shown in Figure 2. The testing was conducted using the ACPA Dual Probe OBSI system, mounted on a 2010 Chevy Malibu and an ASTM SRTT Tire. Only six of the seven textures were measured during this trip and the start point of each of the measured sections is indicated by the approximate milepost location. Three five-second sequential readings were obtained beginning at the start of each of the sections.

Figure 1  Construction Layout of I-70 Surface Textures ¹

Figure 2  I-70 EB Bound Test Section Layout for 2010 OBSI Testing
Testing

Originally, OBSI testing was to occur on May 19 but rain precluded testing. It continued raining through May 20 and testing had to be postponed until May 21. However, this gave the opportunity to observe the sections closer and their behavior during rainfall conditions. It should be noted that the NGCS and CDG sections were ground with equipment using a four foot grinding head. The project used compression seals in the transverse joints and a typical joint opening width was 0.43 inches at the time of testing. The compression seals visually appeared to be recessed fairly significantly with some recesses estimated to be ¾ of an inch.

NGCS Section

Figures 1 thru 7 of Appendix 1 indicate photos of the NGCS surface. Figures 1-4, 6, and 7 indicate burlap drag texture that was not completely removed by the NGCS grinding. The wet pavement makes this very easy to observe as indicated. Figures 1 thru 4 indicate the drag texture is prevalent in the outer 2-3 ft of the outer pass of the right lane. Figure 6 indicates the same problem exists in the outer pass of the inside lane. Figure 7 also indicates a location where a short slab (assuming a replacement) was located and how the texture in the short slab is all NGCS while the approach slab has the drag texture existing. Figure 5 in Appendix 1 indicates a close up of the actual NGCS texture. The typical groove depth was 11/32 inch and the groove spacing approximately 5/8 inch.

The remnant drag texture was not noted on previous ACPA OBSI testing and this could possibly add additional variability to the time series measurements. For the May 21st testing, an attempt was made to keep the tire to the left of the drag texture. Since the section is located on a curve, the success of this attempt is not known, but it is believed that it was successful. Conversations with KDOT shortly after construction, however, indicated that KDOT had observed considerable drag texture remaining in the NGCS section at the time of their texture measurements.

The tested sections of the NGCS and Exposed Aggregate test sections are on a curve, unlike the other sections. What influence, if any, this has on the results is not known.

CDG Section

Figures 1 thru 4 in Appendix 2 indicate photos of the CDG test sections. Figures 1 & 2 indicate the drag texture still existing in the right most pass as in the NGCS section. However, the drag texture is not as prevalent as in the NGCS section. Figure 3 indicates a close up of the CDG texture and Figure 4 indicates the fin profile looking from the side.

Longitudinal Tined Section

Figures 1 and 2 of Appendix 3 indicate photos of the longitudinal tining which was very light. The tining is spaced on approximate ¾” centers. OBSI Testing was conducted on longitudinal tining just before the other test sections and just after the test sections. Figure 2 indicates the location of the two longitudinal sections tested.

Longitudinal Grooved Section

Figures 1 thru 3 of Appendix 4 indicate photos of the longitudinal grooving. The groove spacing was centered on an approximate ¼” spacing. The groove depth in the rightmost pass in the travel lane ranged between 4/32 to 6/32 in. The groove depth of the center pass ranged between 8/32 to 9/32 in.
Exposed Aggregate

Figures 1 thru 4 of Appendix 5 indicate photos of the exposed aggregate test section. Figures 1 and 2 indicate overview shots that indicate the discoloration that is evident in the texture. It is presumed this may be due to the mortar removal process. Figure 3 and 4 indicate close up views of the exposed aggregate texture.

2010 OBSI Results

The 2010 OBSI testing was conducted by initiating the data collection at the start of each of the sections as indicated in Figure 2. Three five-second sequential data sets were obtained. The three samples were then averaged for the both the overall level and spectra to represent each section. All testing was conducted at 60 MPH with the 2009 SRTT tire.

Figure 3 indicates the overall level of each of the tested sections. The NGCS was the quietest followed by the longitudinal grooved, the drag texture, the CDG, longitudinal tining and then the exposed aggregate. The exposed aggregate was 3.6 dBA louder than the NGCS.

Figure 4 indicates the one third octave spectra for each of the sections. The NGCS surface is typically quieter at all center-band frequencies below 2000 Hz while the exposed aggregate surface is typically louder than all textures at center-band frequencies below 4000 Hz. The NGCS surface still exhibits the characteristic dip at approximately 1600 Hz.

As mentioned previously, there is still some drag texture existing within the CDG and NGCS section in the outer grind pass. For both sections an attempt was made to track inside of this texture.
The I-70 test sections have been tested by the ACPA three times. The first time was just after construction on October 19, 2008 (prior to opening to traffic), then again on October 27, 2009, and more recently on May 21, 2010. The initiation point for the start of the sections was the same in 2008 and 2010. However, for the 2009 testing the ISU begin points were used to provide better continuity to the ISU work. In 2010 the vehicle wheelpath was purposely shifted inward to attempt to miss the drag texture existing within the CDG and NGCS sections.

The 2009 and 2010 readings were taken with the 2009 SRTT tire while the 2008 tests were conducted with the original 2006 ACPA SRTT tire. More sections were also tested in 2008 than 2010. Therefore, a time series comparison is somewhat tenuous due to the numerous differences from year to year. To confound matters worse, the longitudinal tined sections and the drag texture may not have used the same initiation points. Since the primary focus of the ACPA testing was to compare the NGCS, CDG, and exposed aggregate surfaces, additional sections were tested as time permitted and at convenient locations.

The test temperatures in 2008 ranged between 67 and 70°F, in 2009 between 59 and 60°F and in 2010 they ranged between 61 to 66°F.

Figure 5 indicates the times series values for selected I-70 sections between 2008 and 2010. It should be noted that while the rank order of the surface textures remains the same, all the textures
appear to have increased in level over time. Figure 6 presents just the increase in level over time for a subset of the sections included in Figure 5. As indicated in Figure 6, the CDG experienced the least amount of change and the NGCS experienced the greatest amount of change. It should be noted that this project used compression seals that appear to be at a significant recess. It is not known whether the recess is increasing over time and could be contributing to the increase in level or not. A sealant depth check should be made during future testing to determine if the sealant condition is changing over time.

Figures 7 thru 9 indicate the one-third octave spectrums for the NGCS, CDG, and EA textures respectively for the years 2008, 2009, and 2010. As indicated in Figure 7, the 2009 and 2010 data correspond better than the 2008 data. As previously mentioned, the 2009 data was probably obtained at a slightly different wheelpath location than the 2010 data and perhaps this is the reason for the somewhat different results even though they were tested with the same tire. That is, the 2009 data may have tracked in the location with more existing drag texture. However, it does appear that above a center-band frequency of 2000 Hz the levels are increasing with time.

Figure 8 indicates the change in spectra for the CDG surface. As before the 2009 result is somewhat different than the 2010 results and it appears that the levels above a center-band frequency of 1250 Hz are increasing.

Figure 9 indicates the changes in spectra for the exposed aggregate surface. Again, it appears that the levels at all center-band frequencies have increased since construction.
Figure 6 Change in OBSI Level Over Time for Selected Textures

Figure 7 One Third Octave Spectra for NGCS Surface between 2008 and 2010
Figure 8 One Third Octave Spectra for CDG Surface between 2008 and 2010

Figure 9 One Third Octave Spectra for Exposed Aggregate Surface between 2008 and 2010
Since only two measurements, presumably on slightly different wheel tracks, have been obtained with the 2009 SRTT tire and only one measurement obtained with the 2006 SRTT tire it is difficult to assign a cause to the apparent increase in level at certain frequencies. Presumably it is a function of changes in the texture but additional data will be needed to verify this assertion.

References

Appendix 1 Photos of NGCS Test Sections

Figure 1 Drag Texture Appearing in Rt WP of NGCS Test Section

Figure 2 Indications of Drag Texture in Right Wheelpath of NGCS Section
Figure 3 Indications of Drag Texture in Right Wheelpath of NGCS Section

Figure 4 Indications of Drag Texture in Right Wheelpath of NGCS Section
Figure 5 Close Up of NGCS Texture with Ruler

Figure 6 Photo of Remaining Drag Texture in Right Pass of NGCS in Both Lanes
Figure 7  Remnant Drag Texture Ending at Transverse Joint of Short Slab in NGCS Section
Appendix 2 Photos of CDG Test Sections

Figure 1 Indications of Drag Texture in Right Wheelpath of CDG Section

Figure 2 Indication of Drag Texture in Right Wheelpath of CDG Section
Figure 3 Close Up of CDG Texture

Figure 4 Close Up View of CDG Texture Indicating Fins
Appendix 3 Photos of Longitudinal Tined Test Section

Figure 1 Close Up of Longitudinal Tining with Ruler

Figure 2 Close Up of Longitudinal Tining
Appendix 4 Photos of Longitudinal Grooved Test Section

Figure 1  Overview Shot of Longitudinal Grooved Section

Figure 2  Close Up of Longitudinal Texture with Ruler
Figure 3  Close Up of Longitudinal Texture
Appendix 5 Photos of Exposed Aggregate Test Section

Figure 1  Approach Onto Exposed Aggregate Test Section

Figure 2  Overview of Exposed Aggregate Test Section Looking East
Figure 3  Close Up of Exposed Aggregate Texture with Ruler

Figure 4  Close Up of Exposed Aggregate Texture