Technical Memorandum

To: Jeff Uhlmeyer

From: Lauren Gardner, Gonzalo Rada, and Kevin Senn

cc: Mustafa Mohamedali

Date: February 19, 2021

Re. Forensic Desktop Study Report: Arkansas LTPP SPS-8 Test Sections

The Long-Term Pavement Performance (LTPP) Specific Pavement Studies-8 (SPS-8) Study of Environmental Effects in the Absence of Heavy Loads test sections 05_0803, 05_0804, 05_0809 and 05_0810 [1] were nominated for a desktop study under TPF-5(332) "LTPP Forensic Evaluations." The Arkansas SPS-8 project consists of two Asphalt Concrete (AC) test sections—05_0803 and 05_0804—and two Jointed Plain Concrete Pavement (JPCP) test sections—05_0809 and 05_0810. These test sections provide an opportunity to compare the performance of test sections with low levels of traffic and varying pavement structures and thicknesses. Accordingly, an investigation and comparison of each test section's performance was recommended. The purpose of this study was to investigate:

- Cause(s) for the increase in fatigue cracking in 2019 on the AC test sections (05_0803 and 05_0804),
- Cause(s) for the spike in longitudinal cracking (both inside and outside the wheel path) in 2014 on the AC test sections (05_0803 and 05_0804),
- Reason(s) for the spike in transverse cracking reported in 2014 on both AC test sections (05_0803 and 05_0804) and the subsequent decrease in transverse cracking reported on test section 05_0804 in 2019, and
- Differences in the reported faulting of the JPCP test sections (05-0809 and 05_0810) over time.

SITE DESCRIPTIONS

LTPP test sections 05_0803, 05_0804, 05_0809 and 05_0810 are located on U.S. 65, southbound, in Jefferson County, Arkansas; U.S. 65 is an urban collector with one lane in the direction of traffic. Each site is classified as being in a Wet, No Freeze climate zone with coordinates (in degrees) of (34.20015, -91.96562), (34.1987, -91.96281), (34.19942, -91.97066), and (34.19991, -91.96846) for test sections 05_0803, 05_0804, 05_0809, and 05_0810, respectively. Photograph 1 shows test section 05_0803 at Station 0+00 looking southbound in 2019, while Map 1 shows the geographical location of the test sections.

[1] First two digits in test section number represent the State Code [05 = Arkansas]. For LTPP Specific Pavement Studies (SPS) test sections, the second set of two numbers indicates the Project Code (e.g., 08= SPS-8), and the final set of two numbers represents the test section number on that project (e.g., 03).

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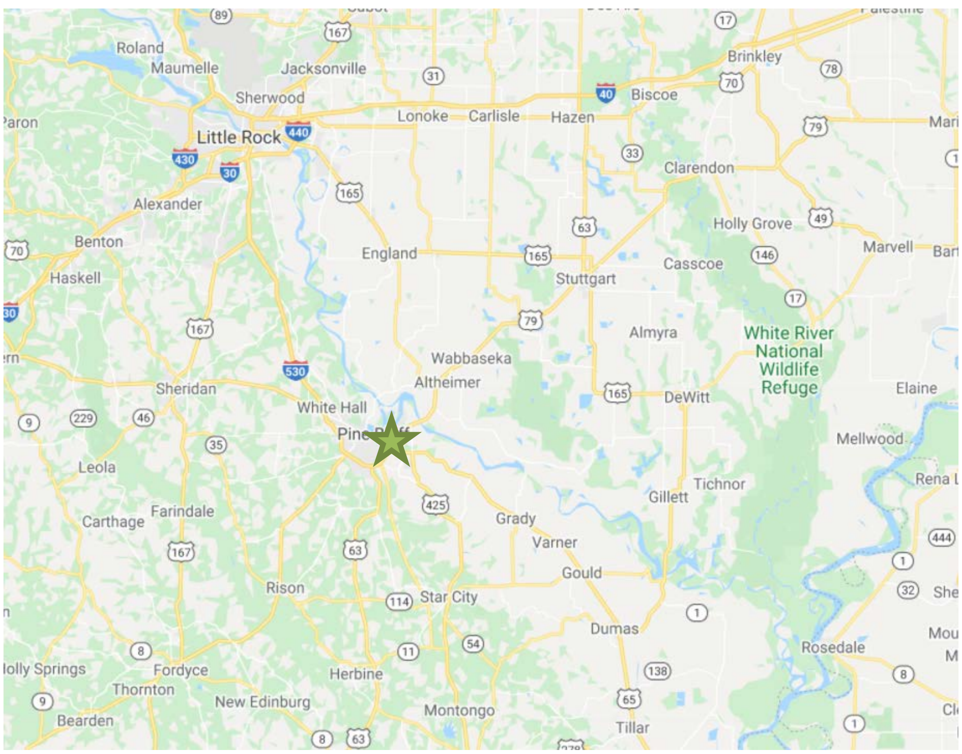
Photograph 1. LTPP Section 05_0803 at Station 0+00 looking southbound in 2019.



Map 1. Geographical location of test sections.

BASELINE PAVEMENT HISTORY

This section of the document presents historical data on the pavement structures and their structural capacity, climate, traffic, and observed surface distresses.

Pavement Structure and Construction History

The four test sections were constructed in 1997 and accepted into the LTPP Program as part of the SPS-8 Study of Environmental Effects in the Absence of Heavy Loads experiment; this experiment was developed to better understand the effect of varying pavement structures (in terms of surface and base thicknesses, specifically) in the absence of heavy loading. SPS-8 AC test sections were to be designed with a surface thickness of 4 inches and a base thickness of 6 inches and a surface thickness of 7 inches and a base thickness of 12 inches. For rigid test sections included in the SPS-8 experiment, test sections were designed to have an 8-inch and 11-inch surface over a 6-inch base.

In Arkansas, the SPS-8 project consists of two AC test sections—05_0803 and 05_0804—and two jointed plain concrete pavement (JPCP) test sections—05_0809 and 05_0810. At the time of incorporation into the LTPP program, test section 05_0803 consisted of 3.7 inches of dense-graded asphalt concrete (0.3-inch less than the specified design thickness) and 7.3 inches of unbound granular base (1.3 inches greater than the specified design thickness) over a fine-grained subgrade soil, while test section 05_0804 consisted of 7.3 inches of dense-graded asphalt concrete (0.3-inch greater than the specified design thickness) and 12.7 inches of unbound granular base (0.7-inch greater than the specified design thickness) over a fine-grained subgrade soil. For both AC test sections, the AC surface was split between two layers—a binder layer and a surface layer. These pavement structures are summarized in Table 1 and correspond to CONSTRUCTION_NO = 1 (CN = 1) in the LTPP database. Neither section reported any additional construction events following their incorporation into the LTPP program. Test sections 05_0809 and 05_0810 were constructed as three layers at the time of incorporation into the LTPP program: 8.7 and 11.5 inches of Portland Cement Concrete (PCC) (0.7-inch and 0.5-inch greater than the specified design thicknesses) and 8 inches of unbound granular base (2 inches greater than the specified design thickness) over a fine-grained subgrade soil for test sections 05_0809 and 05_0810, respectively. Both test sections also received lane-shoulder longitudinal joint sealing in July 2001. Table 1 summarizes the pavement structure of the two JPCP test sections when they were first incorporated into the LTPP program (CN=1).

Table 1. Pavement structure for test sections 05_0803 and 05_0804 (CN=1).

Layer Number	Layer Type	Test Section 05_0803		Test Section 05_0804	
		Thickness (in.)	Material Code Description	Thickness (in.)	Material Code Description
1	Subgrade (untreated)		Fine-Grained Soils: Lean Clay with Sand		Fine-Grained Soils: Lean Clay with Sand
2	Unbound (granular) Base	7.3	Crushed Stone	12.7	Crushed Stone
3	Asphalt Concrete Layer	2.5	Hot Mixed, Hot Laid AC, Dense Graded	5.7	Hot Mixed, Hot Laid AC, Dense Graded
4	Asphalt Concrete Layer	1.2	Hot Mixed, Hot Laid AC, Dense Graded	1.6	Hot Mixed, Hot Laid AC, Dense Graded

Table 2. Pavement structure for test sections 05_0809 and 05_0810 (CN=1).

Layer Number	Layer Type	Test Section 05_0809		Test Section 05_0810	
		Thickness (in.)	Material Code Description	Thickness (in.)	Material Code Description
1	Subgrade (untreated)		Fine-Grained Soils: Lean Inorganic Clay		Fine-Grained Soils: Lean Clay with Sand
2	Unbound (granular) Base	8.0	Crushed Stone	8.0	Crushed Stone
3	Portland Cement Concrete Layer	8.7	Portland Cement Concrete (JPCP)	11.5	Portland Cement Concrete (JPCP)

Pavement Structural Properties

Figure 1 shows the average FWD deflections under the nominal 9,000-pound load plate. The deflection of the sensor located in the center of the load plate is a general indication of the total "strength" or response of all layers in the pavement structure to a vertically applied load. As shown in Figure 1, the deflections reported for the JPCP test sections were lower than those reported for the AC test sections, as expected. Test section 05_0810, the thicker JPCP test section, reported the lowest deflection values, which ranged from 2.8 to 3.3 mils. The other JPCP test section, test section 05_0809, reported the second lowest deflection values, which ranged from 3.9 to 5.2 mils. Of the two AC test sections, the test section with the thicker pavement structure, 05_0804, reported the third lowest deflections over time, ranging from 10.8 to 14.7 mils, while test section 05_0803 reported the highest deflections, ranging from 16.1 to 23.9 mils. For all four test sections, the reported deflections were relatively constant over time, indicating structurally sound pavement structures.

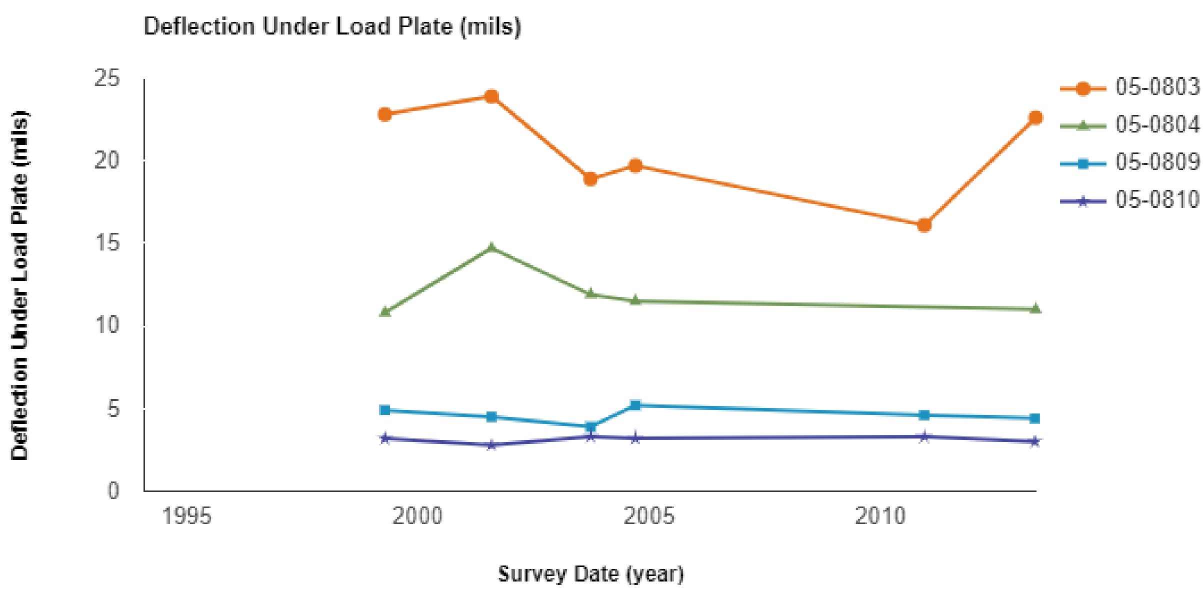


Figure 1. FWD deflections under the load plate over time.

The layer moduli backcalculated from the deflection data were also assessed for the test sections. The pavement structures for the AC test sections were modeled as 3.7 and 7.3 in of AC and 8 and 12.7 in of typical granular base over subgrade (divided into two layers) for test sections 05_0803 and 05_0804, respectively. The pavement structures of the JPCP test sections were modeled as 8.7 and 11.5 in of PCC and 8 in of typical granular base over a subgrade layer and bedrock layer for test sections 05_0809 and 05_0810, respectively. The backcalculated moduli for each layer were calculated for the five FWD test dates between 1999 and 2010 as shown in Figure 2 through Figure 5. Backcalculated moduli for FWD data collected in 2013 were not calculated and therefore, not included in the LTPP database.

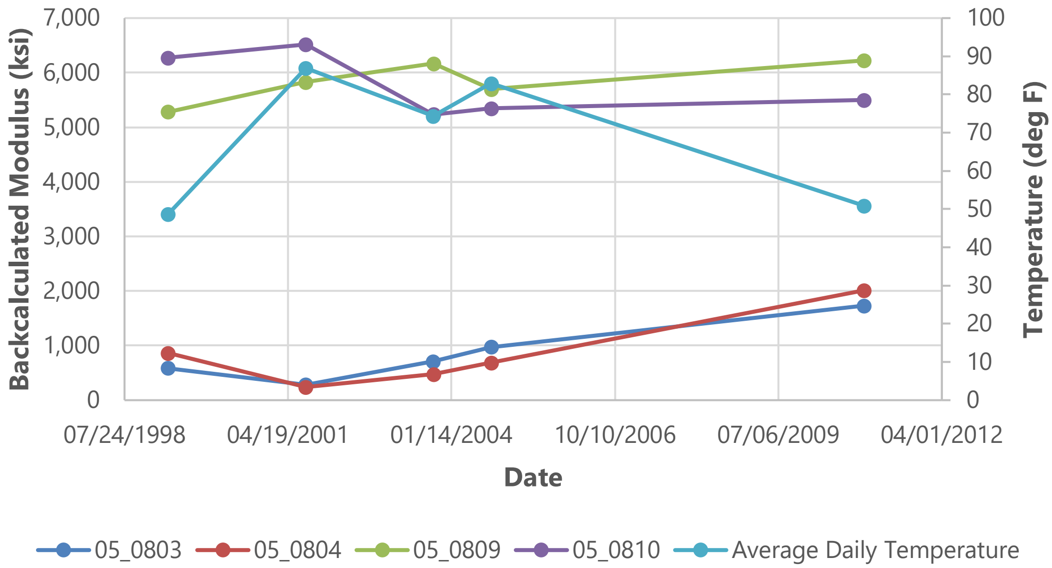


Figure 2. Average backcalculated modulus for surface layer (Layer 1).

Figure 3. Average backcalculated modulus for base layer (Layer 2).

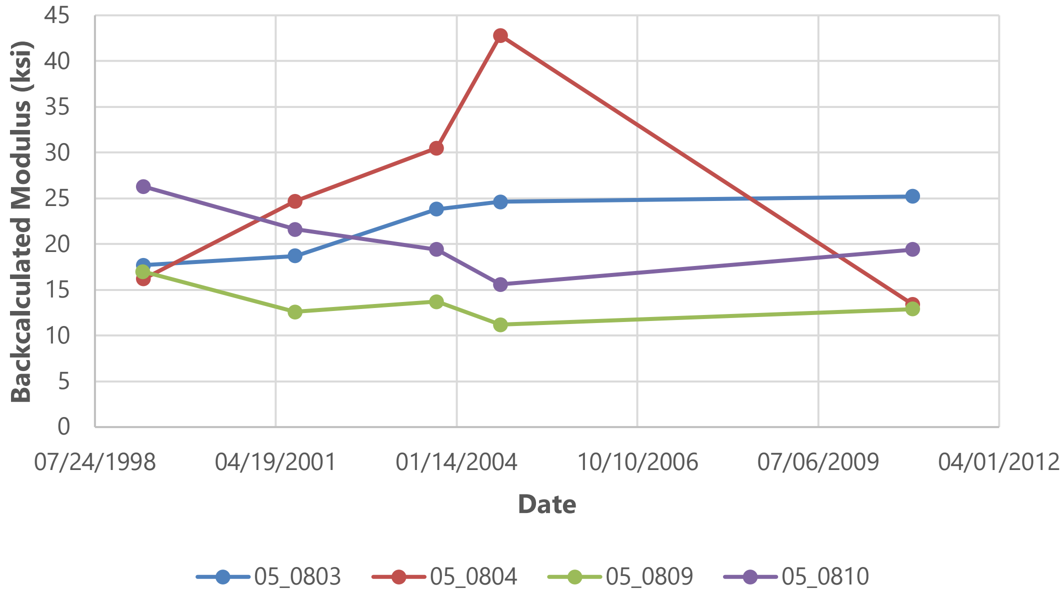


Figure 4. Average backcalculated modulus for top of subgrade (Layer 3).

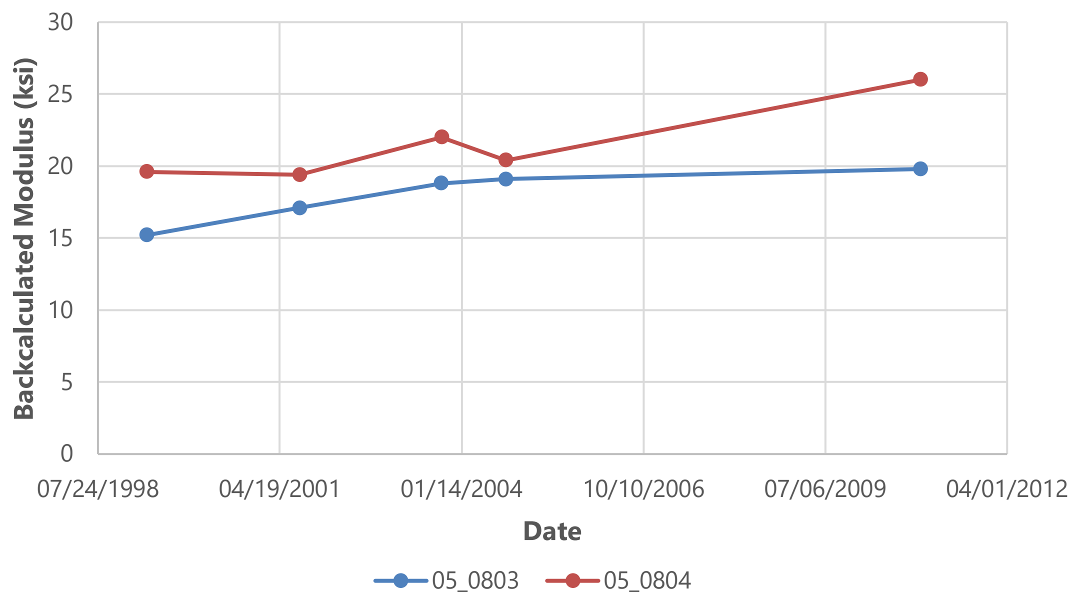


Figure 5. Average backcalculated modulus for subgrade remainder (Layer 4).

The backcalculated moduli were fairly consistent for each test section over time. For Layer 1, the surface layer, the JPCP test sections reported higher backcalculated moduli, ranging from 5,232 to 6,518 ksi, and the AC test sections reported lower moduli, ranging from 240 to 2,012 ksi. While the moduli reported on the AC test sections appear to be reasonable between 1999 and 2004, the values reported in 2010 are notably higher than previous years. This is likely a result of the temperature reported at the time the FWD data was collected. As shown in Figure 2, the highest AC moduli values occur on the days with the coldest average daily temperature (from MERRA), as expected. Layers 2 and 3 (base and fine-grained subgrade) reported similar moduli values for the four test sections. Exceptions include the modulus value reported for test section 05_0809 in 2003 for Layer 2 and the modulus value reported for test section 05_0804 in 2004 for Layer 3; as both values are isolated, they appear to be outliers. Layer 4 reported consistent values for the two AC test sections. As Layer 4 of the JPCP test sections was modeled as bedrock, the layer had an assumed modulus of 500 ksi, which is not reported in the figure below.

The reasonableness of the backcalculated layer moduli was compared to moduli derived from laboratory resilient modulus testing. Table 3 summarizes the laboratory test results for the AC layers, PCC layers, base layers, and subgrade layers. For the AC layers, moduli values are shown for three test temperatures – 41, 77, and 104°F, respectively. As depicted in Figure 6, the AC modulus versus temperature relationship for the field- (FWD-derived backcalculated moduli) and lab-measured resilient moduli appears to be reasonable; there is a clear trend between temperature and the pavement modulus. For the PCC layers, the values reported from the lab testing were notably lower than the field reported values. These differences may be related to the age of the material at the time of lab testing versus the age of the pavement at the time FWD testing was conducted. For the base and subgrade layers, various statistical analyses were conducted for the range of stress states (confining and deviatoric stresses) to which the laboratory samples were subjected. The values of the subgrade and base layers from laboratory testing were similar to the field-reported values.

Table 3. Laboratory Resilient Modulus Test Results

Test Sections	Layer	Temperature (°F)	Number of Samples	Range of moduli values (ksi)
AC Test Sections (05_0803 and 05_0804)	AC-Layer 3	41	3 samples	2,005-2,310
		77	3 samples	676-853
		104	3 samples	202-302
	AC-Layer 4	41	2 samples	2,095-2,403
		77	2 samples	847-848
		104	2 samples	244-251
	Base-Layer 2	N/A	2 samples	11-26
PCC Test Sections (05_0809 and 05_0810)	PCC-Layer 3	N/A	3 samples	3,507-4,800
	Base-Layer 2	N/A	2 samples	7-31
All Test Sections	Subgrade	N/A	6 samples	7-17

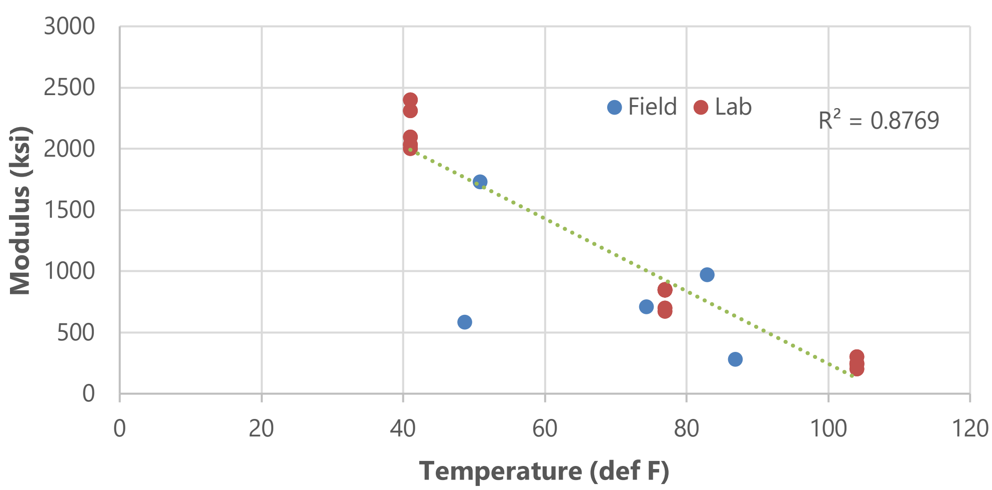


Figure 6. Field- and lab-derived AC resilient modulus values.

Climate History

The time history for average annual precipitation (from MERRA) since 1997 is shown in Figure 7. The average annual precipitation observed over the analysis period fluctuated on a year-to-year basis. However, between 1997 and 2009 and again between 2010 and 2019, the precipitation on the test sections appeared to increase over time. Between 1997 and 2009, the average yearly precipitation observed increased from 62 in in 1997 to 85 in in 2009. From 2010 to 2019, the average yearly precipitation steadily increased from 35 in in 2010 to 80 in in 2019. While some of the spikes in average annual precipitation reported on or near the test section locations were related to unusually highs amounts of precipitation reported throughout the year, such as the spike in precipitation recorded in 2009, the high level of average annual precipitation reported in 2019 is in part due to the flooding reported in June 2019. The event, which was the result of severe weather and heavy rainfall, led to the flooding of the Arkansas River basin and the surrounding areas. This likely had an impact on the pavement distresses reported in 2019 as will be discussed later in the memorandum.

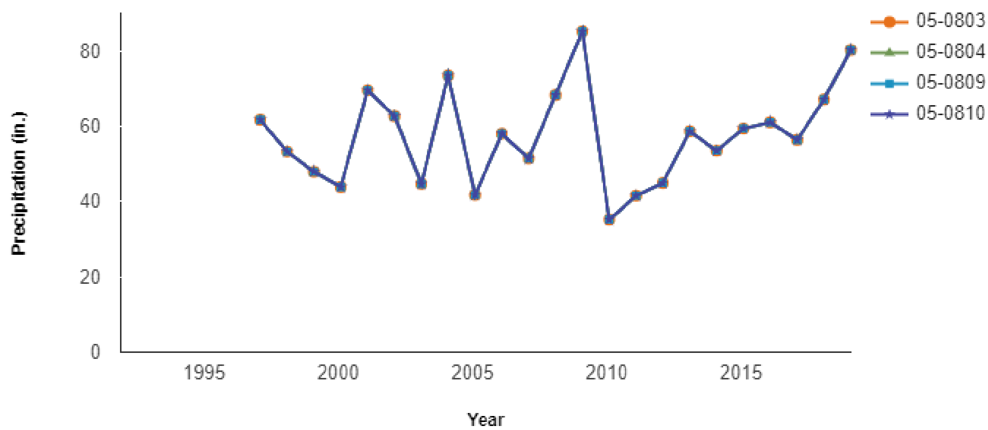


Figure 7. Average yearly precipitation over time.

Figure 8 shows the time history of the average annual freezing index (from MERRA) for the test sites. The freezing index is the summation of the difference between freezing temperature and the average air temperature when it is less than freezing over a year's time. This index is an indicator of the harshness of the winter season relative to issues such as ground frost and low temperature cracking in pavements. As the test sections were in a No-Freeze climate, the freezing index of the test sections was relatively low throughout time. Values ranged from 7.2 deg F deg days in 2012 to 122.4 deg F deg days in 2014.

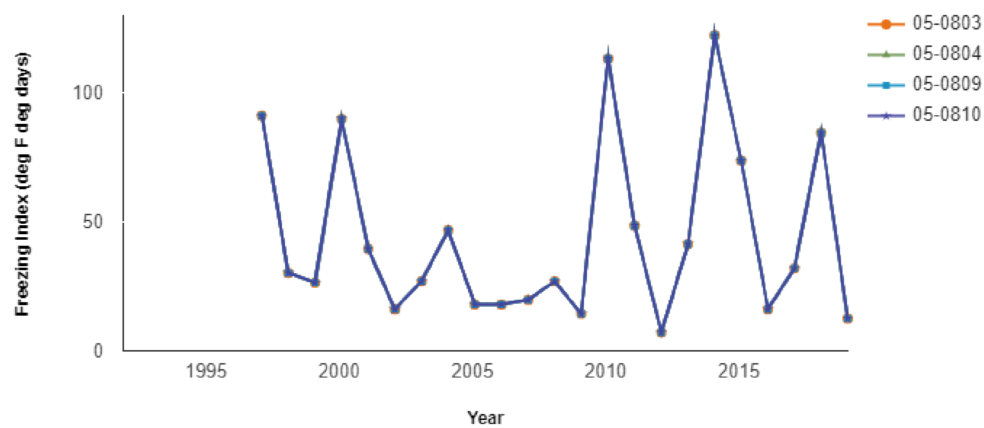


Figure 8. Average annual freezing index over time.

Truck Volume History

The annual truck traffic counts for the test sections were minimal, as expected for SPS-8 test sections. For most years, the reported AADTT ranged from 0-2. Similarly, the average number of ESALs reported on the test sections was minimal for all years. Therefore, traffic loading is not expected to play a damaging role in the overall performance of the test sections over time; rather, the absence of traffic should lead to longer service lives for the pavement test sections as compared to pavements receiving higher loading.

Through the process of reviewing the traffic data for each test section in the study, it was found that data reported for the test site in 2005 and 2006 (within the MEPDG*, TRF_TREND, and TRF_REP tables on InfoPave™) were incorrect; the information being reported was for the wrong test site. Following the identification of the issue, a Data Analysis/Operations Feedback Report (DAOFR) was submitted.

Pavement Distress History

The following summarizes the distresses observed on the test sections between 1997 and 2019. Fatigue/alligator cracking, longitudinal cracking, transverse cracking, IRI, rutting, and faulting were assessed. While longitudinal and transverse cracking were evaluated for both the AC and JPCP test sections, there was no cracking observed on the JPCP test sections during the analysis period.

Fatigue/Alligator Cracking

Figure 9 shows the total reported area of fatigue/alligator cracking between 1997 and 2019 for the two AC test sections. The distress values reported includes both fatigue cracking (inside the wheel path) and alligator cracking (outside the wheel path). Fatigue/alligator cracking was first reported during the manual distress survey in December 2010 for test section 05_0804 and April 2012 for test section 05_0803, 13 and 15 years after the construction of the test sections, respectively. Minimal fatigue/alligator cracking (less than 50 ft^2) was reported on both test sections between 2010 and 2014. However, during the manual distress survey conducted in September 2019, both test sections reported a spike in fatigue/alligator cracking. In 2019, test section 05_0803 reported 549 ft^2 of fatigue/alligator cracking while test section 05_0804 reported 1,625 ft^2 of fatigue/alligator cracking.

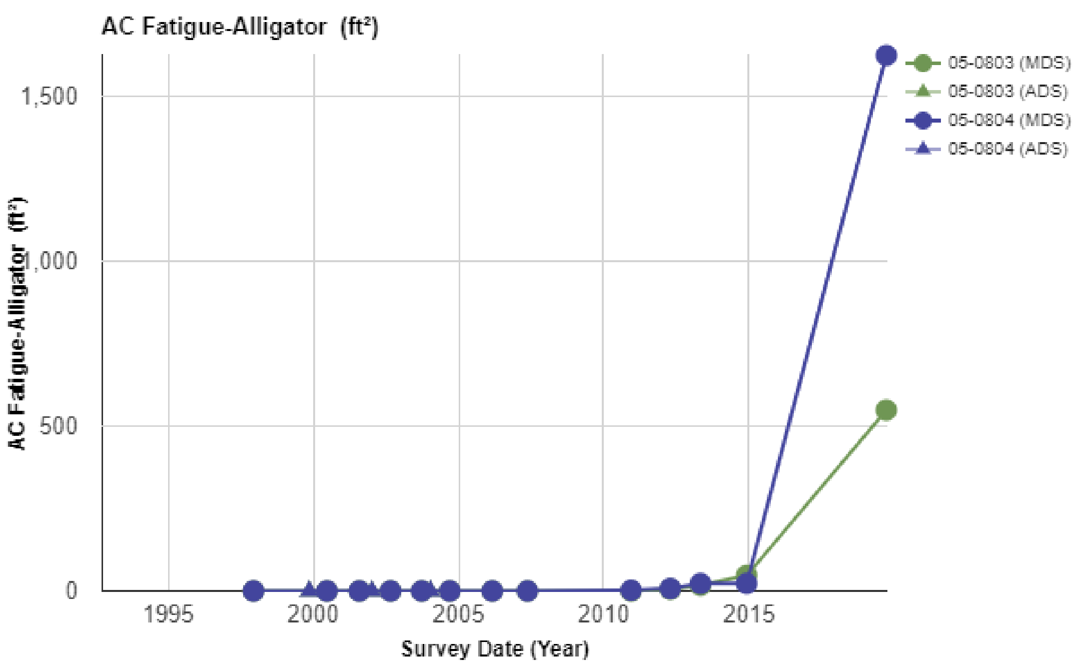


Figure 9. Time history of the length of fatigue cracking.

While no freeze climates typically exhibit more fatigue cracking due to the use of softer AC mixes[2], the amount of fatigue cracking exhibited at the test sections still increased at an abnormal level for a low-traffic roadway. As discussed later in the memorandum, some of the increase in fatigue/alligator cracking observed on the AC test sections may be explained by the way in which distresses were captured in the manual distress surveys in 2014 and 2019. As depicted in Figure 10, most of the additional fatigue cracking observed in 2019 is located in areas where wheel path longitudinal cracking and transverse cracking already existed. Therefore, in 2019, these cracking types were classified as fatigue/alligator cracking, which lead to an increase in fatigue/alligator cracking and a decrease in other cracking types.

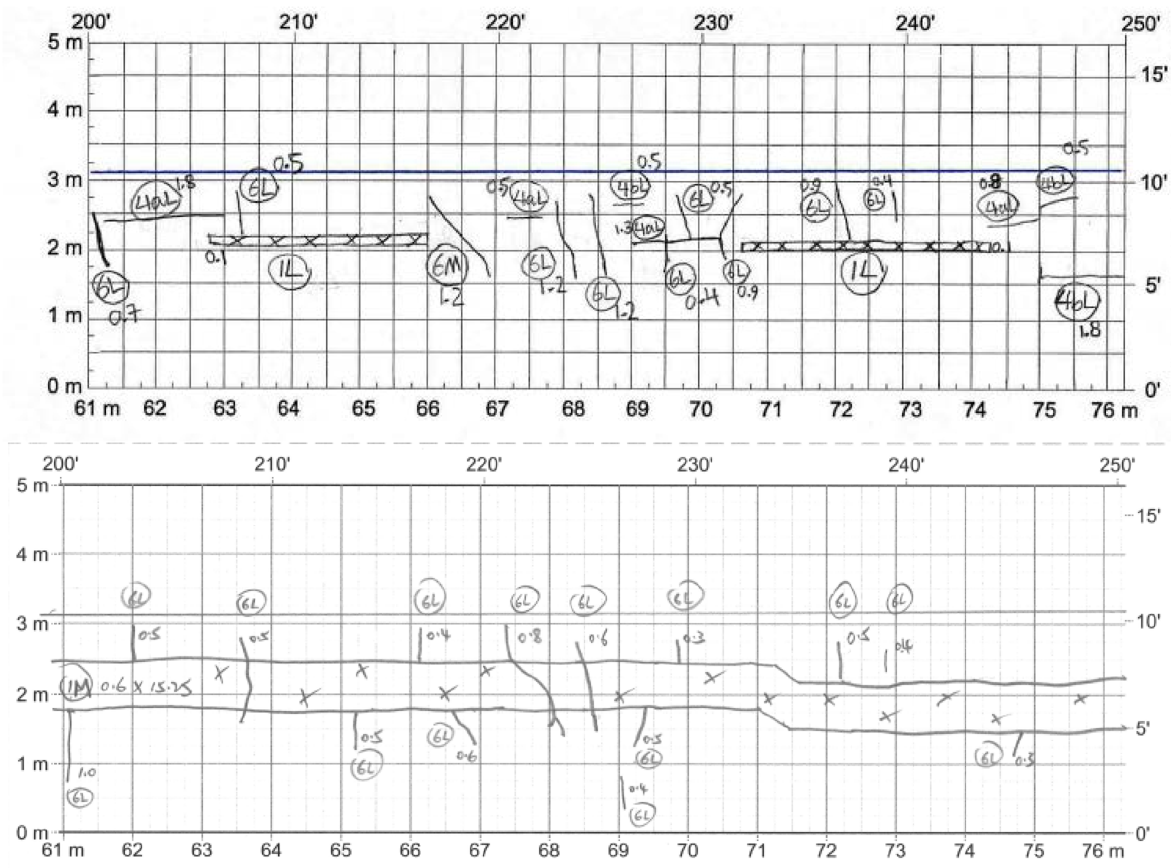


Figure 10. Fatigue cracking propagation on test section 05_0803 in 2014 (top) and 2019 (bottom).

The sharp increase in fatigue/alligator cracking also coincides with high amounts of precipitation (80 inches) reported in 2019. As stated previously, this area of Arkansas experienced historic levels of flooding, which is likely one cause of this increase in fatigue/alligator cracking. As water infiltrates the pavement, unbound granular layers tend to weaken (especially when reaching saturation conditions), which can contribute to the observed cracking. Another potential reason for the observed increase in fatigue cracking over time is that the AC pavement surface layer is undergoing age hardening (or oxidation), hardening leads to a more brittle asphalt surface layer. Oxidation is influenced by the asphalt binder used, film thickness, aggregate gradation, in situ moisture content, and AC-mix percentage of air voids. To better

[2] Titus-Glover, L., Darter, M., and Von Quintus, H. (2019). *Impact of Environmental Factors on Pavement Performance in the Absence of Heavy Loads* (FHWA-HRT-16-084). Washington, DC: Federal Highway Administration.

understand whether oxidation played a role in increased levels of fatigue/alligator cracking, it is suggested that each of the factors mentioned be assessed using information collected on the sections at the time of construction as well as through lab tests of the existing pavement material. Finally, the fatigue/alligator cracking observed may also be material or construction related. Both AC test sections were notably constructed as two AC layers, which may have resulted in debonding between the two layers and therefore, an effective reduction in the structural capacity of the test sections.

As fatigue cracking indicates that a pavement is either structurally inadequate or has reached the end of its service life, the high percentage of what appears to be fatigue related cracking observed on the thicker pavement structure (section 05_0804) is counterintuitive, especially in light of the limited amount of traffic at the site. Because thicker layers of asphalt concrete and subgrade implies increased strength to withstand loads and section 05_0804 is thicker than section 05_0803, further investigation of the high levels of what appears to be fatigue-related cracking observed on section 35_0804 is needed.

Longitudinal Cracking

Non-wheel path (NWP) longitudinal cracking, depicted in Figure 11, was first reported during the distress survey in August 2001 for test section 05_0804 when 3 ft of cracking was reported. The reported NWP longitudinal cracking remained minimal on the test section between 2001 and 2010 and began to increase between 2010 and 2014. By December 2014, test section 05_0804 reported 59 ft of NWP longitudinal cracking while test section 05_0803 reported 14 ft of cracking (the only time NWP longitudinal cracking was reported on this test section). However, no NWP longitudinal cracking was reported during the next distress survey in September 2019. The majority of NWP longitudinal cracking observed prior to 2019, while minimal, was of low severity and was reported midlane, just outside the wheel path for both test sections. Therefore, the drop in NWP longitudinal cracking in 2019 is related to the cracking being incorporated into the higher amounts of fatigue/alligator cracking reported in 2019.

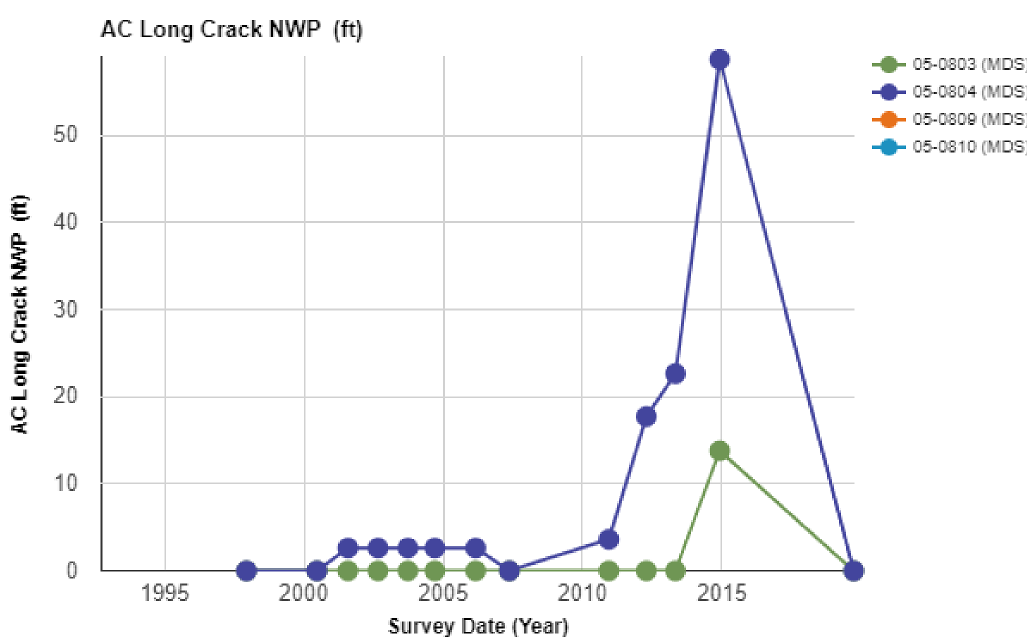


Figure 11. Time history of the length of NWP longitudinal cracks.

Wheel path (WP) longitudinal cracking followed a similar trend to the NWP longitudinal cracking reported on the AC test sections as depicted in Figure 12. In fact, the total length of WP and NWP cracking, when combined, was approximately the same for both test sections. However, unlike NWP longitudinal cracking, test section 05_0803 reported more WP cracking than test section 05_0804; recognizing for both test sections, the cracking reported was minimal.

In May 2007, 10 years after the construction of the test sections, 3 ft of WP longitudinal cracking was reported on test section 05_0804. WP longitudinal cracking was first reported on test section 05_0803 in April 2012 when 3 ft of cracking was observed but continued to increase between April 2012 and December 2014. Both test sections reported a spike in WP longitudinal cracking in December 2014, when 55 ft and 14 ft of WP longitudinal cracking were reported on test sections 05_0803 and 05_0804, respectively. However, no WP longitudinal cracking was reported during the next distress survey in September 2019, due to the WP longitudinal cracking being incorporated into the higher amounts of fatigue/alligator cracking reported in 2019.

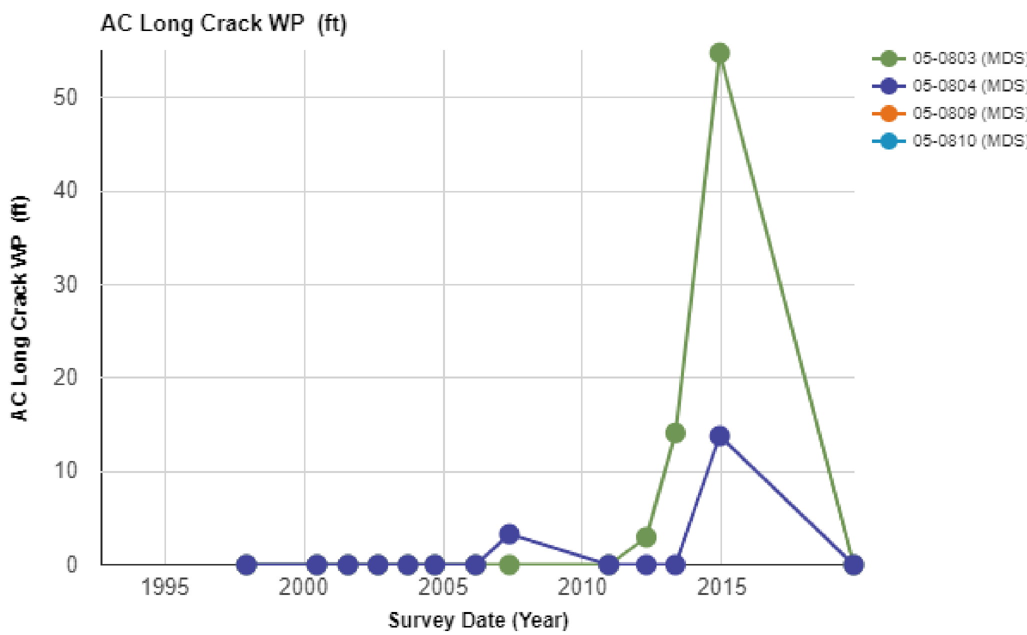


Figure 12. Time history of the length of WP longitudinal cracks.

Transverse Cracking

Data on transverse cracking was collected between 1997 and 2019, as shown in Figure 13 and Figure 14. Test section 05_0803 first reported transverse cracking during the manual distress survey in May 2007, 10 years after the construction of the test sections, when 2 feet of transverse cracking (1 crack) was observed. Transverse cracking was first reported on test section 05_0804 in December 2010, when 9 ft (5 cracks) was reported on the test section. Both test sections reported an increase in transverse cracking between December 2010 and December 2014, at which point 190 ft (90 cracks) and 88 ft (42 cracks) of transverse cracking was reported on test sections 05_0804 and 05_0803, respectively. The reported length of each transverse crack was relatively short, typically ranging from 1 to 2 ft. In September 2019, during the most recent pavement distress survey, the amount of transverse cracking reported increased for test section 05_0803 to 159 ft (72 cracks) and decreased for test section 05_0804 to 50 ft (29 cracks). The decrease in transverse cracking observed on test section 05_0804 is the result of some of the previously reported transverse cracking from 2014 being captured as fatigue/alligator cracking in 2019. The increase (rather than decrease) in transverse cracking on test section 05_0803 may be partially explained by the fact that there is substantially more fatigue/alligator on test section 05_0804 than test section 05_0803. While the reported transverse cracking on both sections remained minimal, it is hypothesized that its initiation and propagation is binder related or due to aging/oxidation of the AC surface layer.

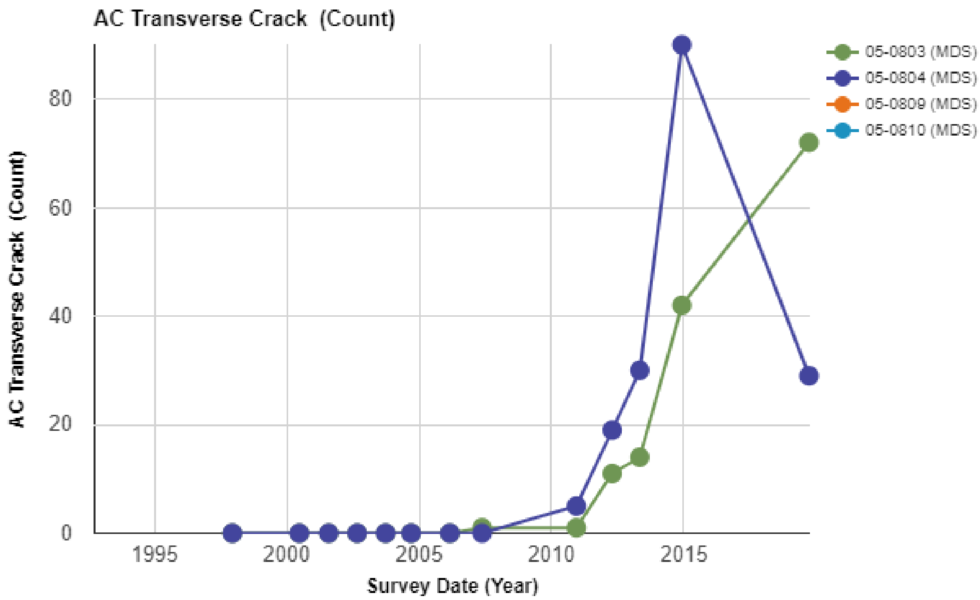


Figure 13. Time history of the number of transverse cracks.

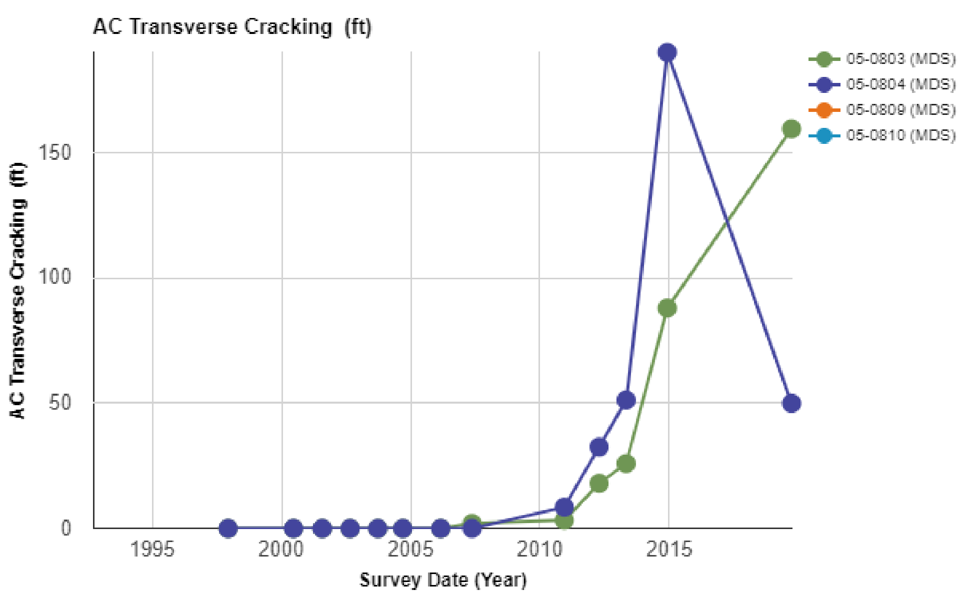


Figure 14. Time history of the length of transverse cracking.

Rutting

The average rut depths observed for the AC test sections between 1997 and 2019 are shown in Figure 15. Both test sections reported relatively low rut depths over time. Test section 05_0803 reported rut depths between 0.04 in and 0.12 in (1999) while test section 05_0804 reported rut depths between 0.04 in and 0.16 in (2004). Both test sections showed variability in rut depths reported over time, but this variability was mostly within error.[3]

[3] Simpson, A., Rada, G., Bryce, J., Serigos, P., Visintine, B. and Groeger, J. (2018). *Interstate Highway Pavement Sampling Data Quality Management Plan*. Washington, DC: Federal Highway Administration.

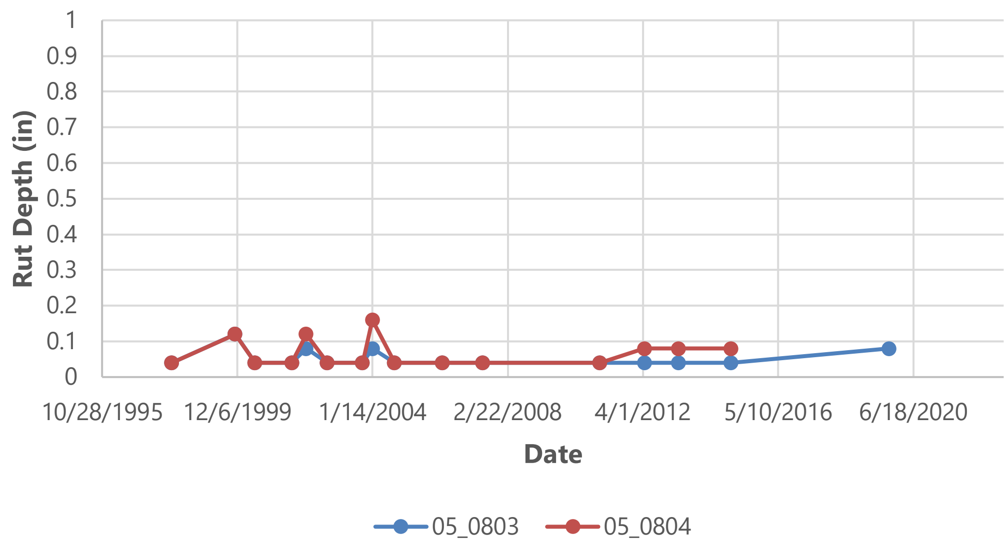


Figure 15. Time history plot of average rut depth.

Faulting

The average faulting observed over time on the JPCP test sections is shown in Figure 16. The faulting on both test sections was minimal and fluctuated over time. For test section 05_0810, faulting ranged from -0.01 in (2000) to 0.04 in (2002). Test section 05_0809 reported faulting between 0 in and 0.03 in (2019). The average faulting for the JPCP test sections is classified as "Good" based on FHWA performance definitions.

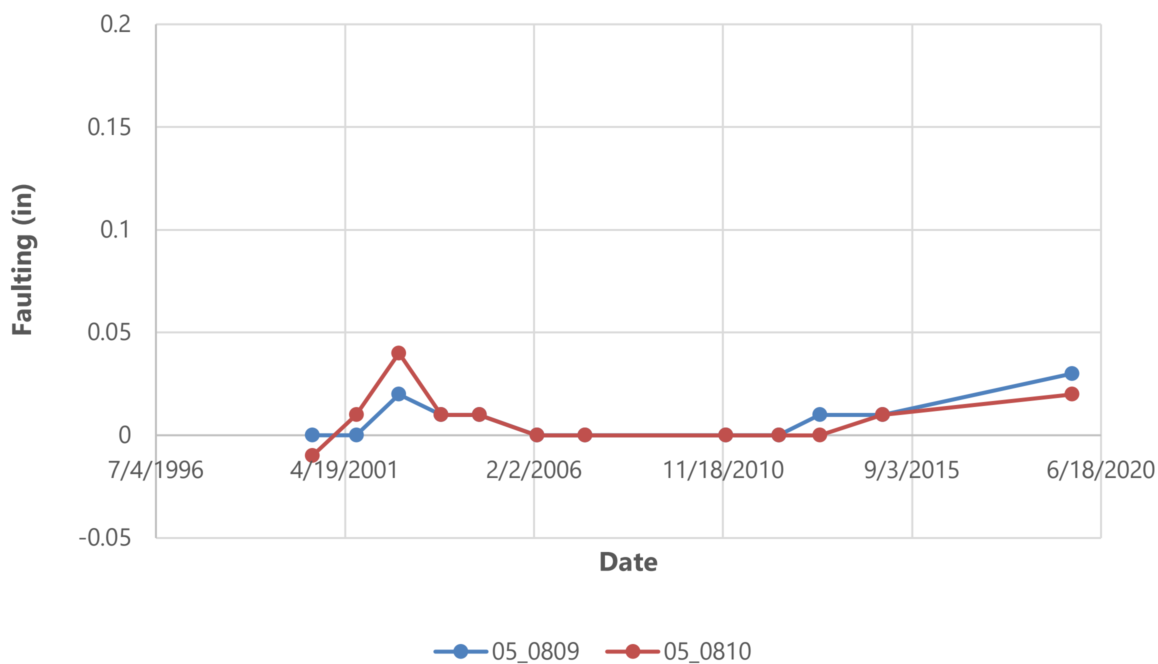


Figure 16. Time history plot of average faulting.

IRI

The average IRI measurements for all four test sections over time are shown in Figure 14. The two AC test sections reported lower IRI measurements than the JPCP test sections; this is likely because the IRI of the

JPCP test sections is affected by the faulting and joints along the sites. Test section 05_0803 reported the lowest average IRI measurements, which increased from 72 in/mi in 1998 to 79 in/mi in 2019, while test section 05_0804 reported the second lowest IRI measurements, which increased from 88 in/mi in 1998 to 90 in/mi in 2019. The average IRI for both the AC test sections is classified as "Good" based on FHWA performance definitions. For the JPCP sites, test section 05_0809 reported the lower average IRI measurements, increasing from 107 in/mi in 1998 to 110 in/mi in 2019, while test section 05_0810 reported the highest average IRI measurements, which increased from 108 in/mi in 1998 to 117 in/mi in 2019. The average IRI for the JPCP test sections is classified as "Fair" based on FHWA performance definitions. It is important to note that the smoother a pavement is during the construction of the pavement, the slower the expected deterioration rate over time.[4] Therefore, the initial smoothness of each test section, likely played a role in how each test section performed over the analysis period.

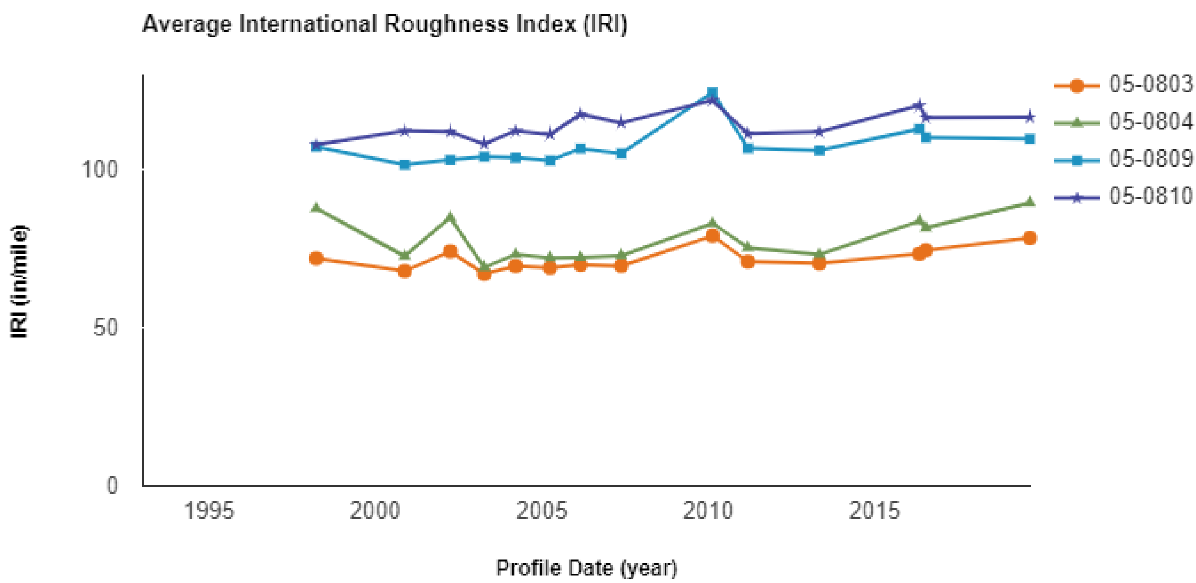


Figure 17. Time history plot of pavement roughness.

SUMMARY OF FINDINGS

LTPP test sections 05_0803, 05_0804, 05_0809 and 05_0810 are located on U.S. 65, southbound, in Jefferson County, Arkansas; U.S. 65 is an urban collector with one lane in the direction of traffic. The four test sections were constructed in 1997 and accepted into the LTPP Program as part of the SPS-8 Study of Environmental Effects in the Absence of Heavy Loads experiment. At the time of incorporation into the LTPP program, test section 05_0803 consisted of 3.7 inches of dense-graded asphalt concrete (split between two layers) and 7.3 inches of unbound granular base over a fine-grained subgrade soil while test section 05_0804 consisted of 7.3 inches of dense-graded asphalt concrete (also split between two layers) and 12.7 inches of unbound granular base over a fine-grained subgrade soil. Neither section reported an additional construction event following their incorporation into the LTPP program. Test sections 05_0809 and 05_0810 were constructed as three layers at the time of incorporation into the LTPP program: 8.7 and 11.5 inches of Portland Cement Concrete (PCC) and 8 inches of unbound granular base over a fine-grained

[4] R.W. Perera, S.D. Kohn, *LTPP Data Analysis: Factors Affecting Pavement Smoothness. National Cooperative Highway Research Program (NCHRP),* Washington, D.C., United States, Project Report 20-50[8/13], 2001.

subgrade soil for test sections 05_0809 and 05_0810, respectively. Both test sections also received lane-shoulder longitudinal joint sealing in July 2001. Key findings of the desktop study include:

1. **The cause(s) for the increase in fatigue cracking in 2019 on the AC test sections (05_0803 and 05_0804).** Some of the increase in fatigue/alligator cracking observed on the AC test sections is related to other cracking types in the wheel path being captured as fatigue/alligator cracking starting in 2019. Most of the additional fatigue cracking observed in 2019 is located in areas where wheel path longitudinal cracking and transverse cracking already existed. Other potential causes for the increase in fatigue/alligator cracking along the test section include high levels of precipitation due to a flooding event in 2019, aging/oxidation of the AC layers, and construction or material inconsistencies.
2. **The cause(s) for the spike in longitudinal cracking (both inside and outside the wheel path) in 2014 on the AC test sections (05_0803 and 05_0804).** The increase and subsequent drop in NWP and WP longitudinal cracking on the AC test sections is related to the fatigue/alligator cracking observed on the test sections. Most of the additional fatigue cracking observed in 2019 was located in areas where wheel path longitudinal cracking and transverse cracking already existed.
3. **The reason(s) for the spike in transverse cracking reported in 2014 on both AC test sections (05_0803 and 05_0804) and the subsequent decrease in transverse cracking reported on test section 05_0804 in 2019.** The decrease in transverse cracking observed on test section 05_0804 is the result of some of the previously reported transverse cracking from 2014 being captured as fatigue/alligator cracking in 2019. While the reported transverse cracking on both sections remained minimal, it is hypothesized that its initiation and propagation is binder related or due to aging/oxidation of the test sections.
4. **The differences in the reported faulting of the JPCP test sections (05-0809 and 05_0810) over time.** The faulting on both test sections was minimal and fluctuated over time. There was no notable difference in the reported faulting on the two test sections, and the average faulting for both was classified as “Good” based on FHWA performance definitions.
5. **The differences in the reported IRI of the AC and JPCP test sections over time.** The two AC test sections reported lower IRI measurements than the JPCP test sections; this is likely because the IRI of the JPCP test sections is affected by the faulting and joints along the sites. Additionally, the initial smoothness of each test section is a major factor in how test sections perform in terms of smoothness over time.

FORENSIC EVALUATION RECOMMENDATIONS

It is recommended the desktop study be extended to further pursue information on the causes behind the performance of the test sections described by carrying out the following:

- Additional FWD testing to determine if deflections remained consistent over time or if the structural capacity of the pavements has begun to deteriorate. However, this activity is not considered critical.
- Perform coring, just outside the test sections, in order to address the following that could help explain one or more of the issues raised in this memorandum:
  - Provide asphalt concrete layer material for use in laboratory testing. This will be used to better understand whether the AC test sections experienced any debonding or aging/oxidation.
- Continued monitoring of these test sections is recommended.

- A discussion should be held with Arkansas DOT staff familiar with the SPS-8 test sections to better understand the construction practices used on these test sections as well as the test sections' performance over time (specifically with regards to fatigue/alligator cracking on the AC test sections). Additionally, a comparison of the SPS-8 construction practices and the Arkansas construction practices at the time these test sections were incorporated into LTPP study should be conducted