Cracking Performance of Several Polymer Modified Asphalt and Geotextile Interlayer Test Sections After Eighteen Years

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A full-scale test road was constructed on US 64 between Cimarron and Ute Park, New Mexico in 1987. The purpose of this test pavement was to evaluate three new polymer modifiers used as additives in the asphalt pavement. A controlled, full-scale experiment was designed and constructed to evaluate the long-term performance of these admixtures at two levels of modification each. Control sections were constructed in conjunction with each polymer section resulting in a total of fourteen test sections in the westbound direction of the two-lane facility. In addition, test sections to compare fabric interlayer performance were added during construction in the opposite lanes. These fourteen test sections include pavement overlay with fabric as an interlayer and without fabric as an interlayer. Complete documentation of this work is contained in an earlier research paper (Shuler, et al, 1992). This paper documents the condition of the pavement test sections after eighteen years service and indicates that while differences exist in cracking performance between the different polymer modifiers, and differences between interlayer and non-interlayer sections is also present, the difference in cracking performance between the polymer modified westbound lanes and the unmodified eastbound lanes is very significant.

Keywords: Polymer modified asphalt, low temperature cracking, long term performance

Introduction

Modifying asphalt with polymers to enhance pavement performance has become a common practice in asphalt pavement technology (Stuart, 2001, NCHRP, 2001, Bahia, 2001). However, twenty years ago this practice was just beginning to become popular. A lack of specifications for purchasing such modified asphalts lead the New Mexico DOT to finance a series of full-scale experiments to determine the performance characteristics of several polymer modifiers. Full-scale experiments were necessary due to a lack of accelerated loading facilities (Stuart, 1999). Therefore, a full-scale test road was constructed on US 64 between Cimarron and Ute Park, New Mexico in 1987 (Shuler, 1992). The purpose of this test pavement was to evaluate three new polymer modifiers used as additives in the asphalt pavement. A controlled, full-scale experiment was designed and constructed to evaluate the long-term performance of these admixtures at two levels of modification each. Control sections were constructed in conjunction with each polymer section resulting in a total of fourteen test sections in the westbound direction of the two-lane facility. In addition, test sections to compare fabric interlayer performance were added during construction in the opposite lanes. These fourteen test sections include pavement overlay with fabric as an interlayer and without fabric as an interlayer. Complete documentation of this work is contained in an earlier research paper (Shuler, et al, 1992). This paper documents the condition of the pavement test sections after eighteen years service and indicates that while differences exist in cracking performance between the different polymer modifiers, and differences between interlayer and non-interlayer sections is also present, the difference in cracking performance between the polymer modified westbound lanes and the unmodified eastbound lanes is very significant.

A visit to the test road was conducted on May 18, 2005 to observe the overall condition of the pavement and to determine the extent and type of distress present. Observations made during this visit indicated that a significant difference in performance existed between sections of the pavement and that a complete condition survey was warranted. Some of the original test section markers placed during construction in 1987 remained intact and were judged suitable for locating original test sections.

A new condition survey was conducted on July 24 and 25, 2005. After traffic control was established by New Mexico DOT, the test sections were evaluated by walking from the east end of the project at approximately Milepost 304. The condition of each test section was recorded on the data sheets shown in Appendix A by measuring the length of each type of crack observed using a measuring wheel for each of five, one hundred foot segments within each test section. The process used was the same as the process used in 1987 to record the pavement condition before the overlay was applied. Approximate locations of the test sections evaluated during this condition survey are shown in Table 1. The average cracking observed during the 2005 field survey is shown in Table 2 and graphed in Figures 1 through 3 for the westbound lanes and Figures 4 through 6 for the eastbound lanes.

Westbound test sections consisted of three polymer modifiers including Styrelf at 3 and 6 percent polymer by weight of asphalt (S3 and S6, respectively in Table 2), Kraton at 3 and 6 percent (K3 and K6, respectively), and Elvax at 2 and 4 percent (E2 and E4, respectively). Styrelf is a tradename for a styrene-butadiene block copolymer modifier cross-linked with small quantities of sulphur. Kraton is a tradenamed block copolymer of styrene and butadiene manufactured by Shell Chemical. Elvax is ethylene vinyl acetate produced by Dupont. Control sections were placed alternately with corresponding polymer modified test sections along the alignment for performance comparison (labeled 'C' in Table 2). The base asphalt binder used in the westbound lanes was a 120-150 penetration grade materials from Navajo Refinery in Artesia, NM. The eastbound control sections consisted of an unmodified asphalt concrete overlay placed over a geotextile fabric.

Table 1: Test Section Locations

Section	Lane	Station (E to W)	Observed Odometer Reading 7-24-05	Observed Location, MP	Approximate Location, MP
1	WB	32488	0.00		304.048
		33000	0.09		303.951
2	EB	35900	0.55		303.402
		37800	0.64		303.042
3	EB	37500			303.099
		38000		303.004	303.004
4	WB	37500	0.90		303.099
		38000	1.00		303.004
5	WB	39250			302.767
		39750			302.673
6	EB	42600		302.032	302.032
		43100			302.079
7	EB	43675			301.970
		44175			301.875
8	WB	43675			301.970
		44175			301.875
9	WB	45200			301.681
		45700			301.587
10	EB	48000			301.151
		48500			301.056
11	WB	48000			301.151
		48500			301.056
12	EB	49300			300.905
		49600	3.20		300.848
13	EB	49600			300.848
		49800	3.24		300.808
14	EB	50250	3.33		300.718
		50750	3.42		300.628
15	WB	50250	3.33		300.718
		50750	3.42		300.628
16	WB	52000	3.66		300.388
		52500	3.75		300.298
17	EB	54500	4.13		299.918
		55000	4.23		299.818
18	WB	54500			299.918
		55000			299.818
19	EB	56000	4.42		299.628
		56500	4.51		299.538
20	WB	58000	4.79		299.258
		58500	7.89		296.158
21	EB	60500	5.27		298.778
		61000	5.36		298.688
22	WB	60500			298.778
		61000			298.688
23	EB	62200	5.59		298.458
		62700	5.69		298.358
24	WB	65000	6.12		297.928
		65500	6.22		297.828
25	WB	66000	6.31		297.738
		66500	6.40		297.648
26	EB	69400	6.95		297.098
		69900	7.05		296.998
27	WB	71700	7.39		296.658
		72200	7.48		296.568
28	EB	71700	7.39		296.658
		72200	7.48		296.568

Table 2: Average Linear Feet of Cracking Observed in 2005

		WB Average		
Section Number	WB Section	Long	Transv	Total
1	C	55.8	32.4	88.2
4	S6	112	81.8	193.8
5	C	87.4	43.6	131
8	S3	104.2	71	175.2
9	C	78	31	109
11	K6	201	57.8	258.8
15	S6	149.8	81.2	231
16	C	116.8	25.8	142.6
18	K3	172.6	30.6	203.2
20	C	301	111.8	412.8
22	E4	179.8	102	281.8
24	C	104	38	142
25	E2	291.6	69.6	361.2
27	C	99.4	36.6	136

		EB Average		
Section Number	Section Material	Long	Transv	Total
2	NF	0.8	25.8	26.6
3	F			
6	NF	14	10.6	24.6
7	F	5	20.2	25.2
10	F	32.4	9.2	41.6
12-13	NF	28.2	32.6	60.8
14	F	27.6	39.8	67.4
17	F	28.4	31.2	59.6
19	NF	121.2	42.2	163.4
21	F	48.8	40.2	89
23	NF	15.6	35.2	50.8
26	NF	0.6	35.6	36.2
28	F	7	37.2	44.2

Binder used in the eastbound lanes was an 85-100 penetration grade from the Diamond Shamrock refinery in Sunray, TX. Test sections were placed alternately with the control sections consisting of 500 feet of overlay without geotextile between the existing pavement and the overlay. These sections are labeled in Table 2 as either 'F' for containing fabric, or 'NF' for no fabric.

Results

Cracking in the test sections was measured before construction in 1987 and again in 2005. Cracks were measured physically using a roll-a-tape measuring wheel by walking the length of the project and measuring each crack in the pavement. The results of these measurements are presented in Figures 1 through 3 for the westbound lanes and Figures 4 through 6 for the eastbound lanes.

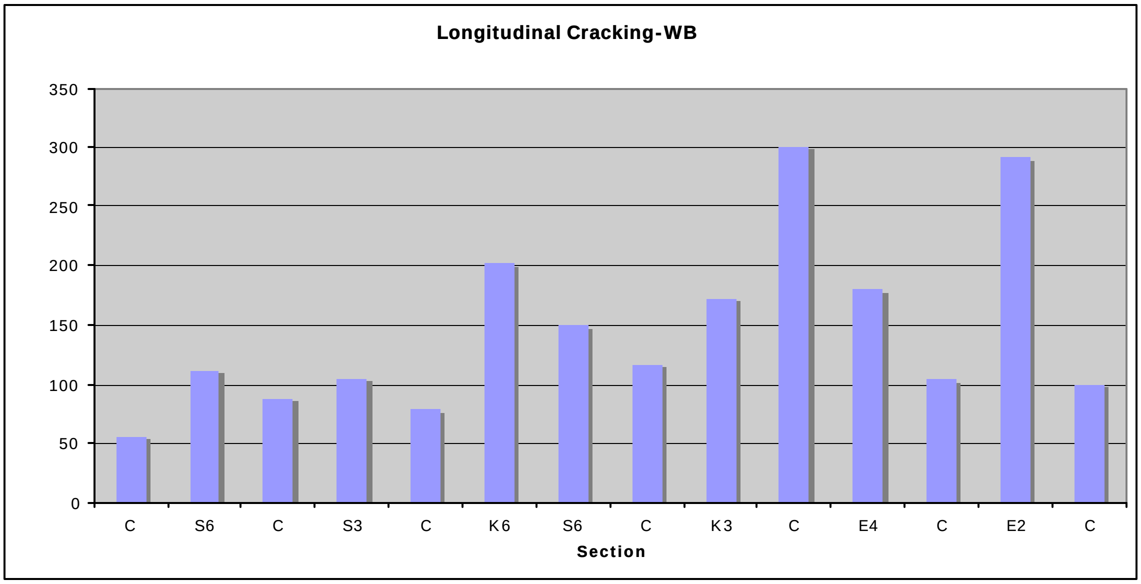

Figure 1: Longitudinal Cracking Westbound US64

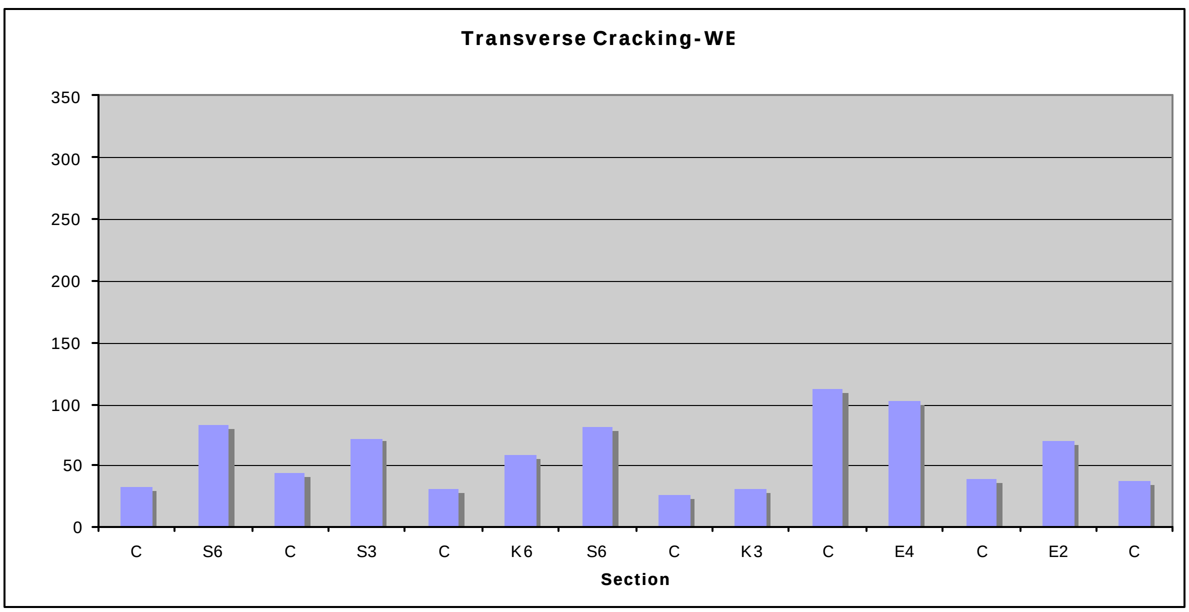

Figure 2: Transverse Cracking Westbound US64

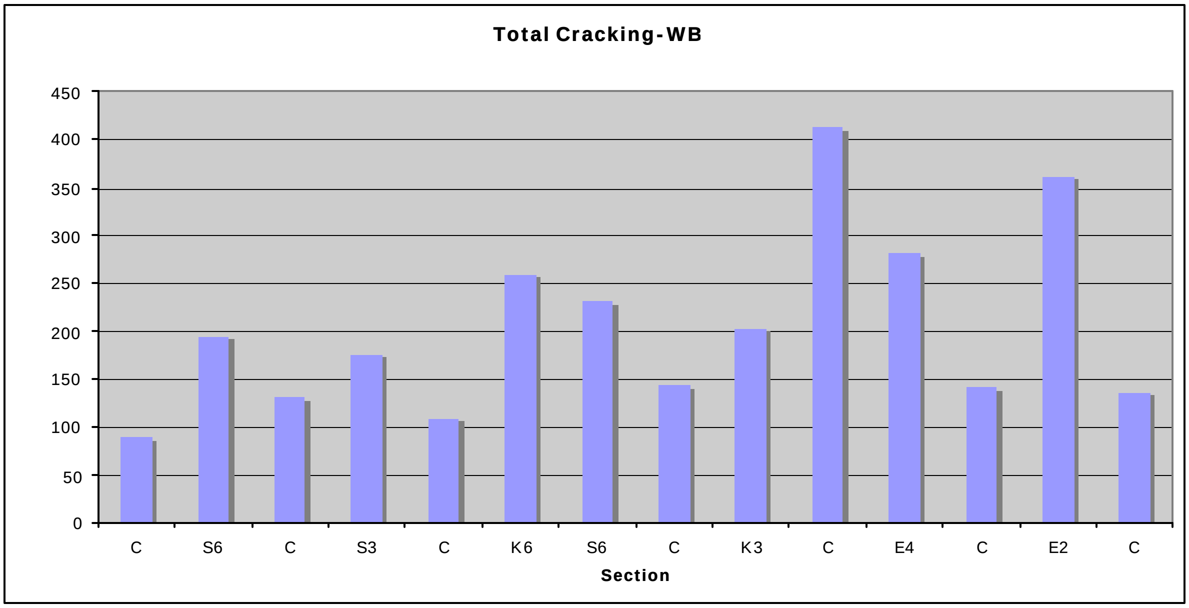

Figure 3: Total Cracking Westbound US64

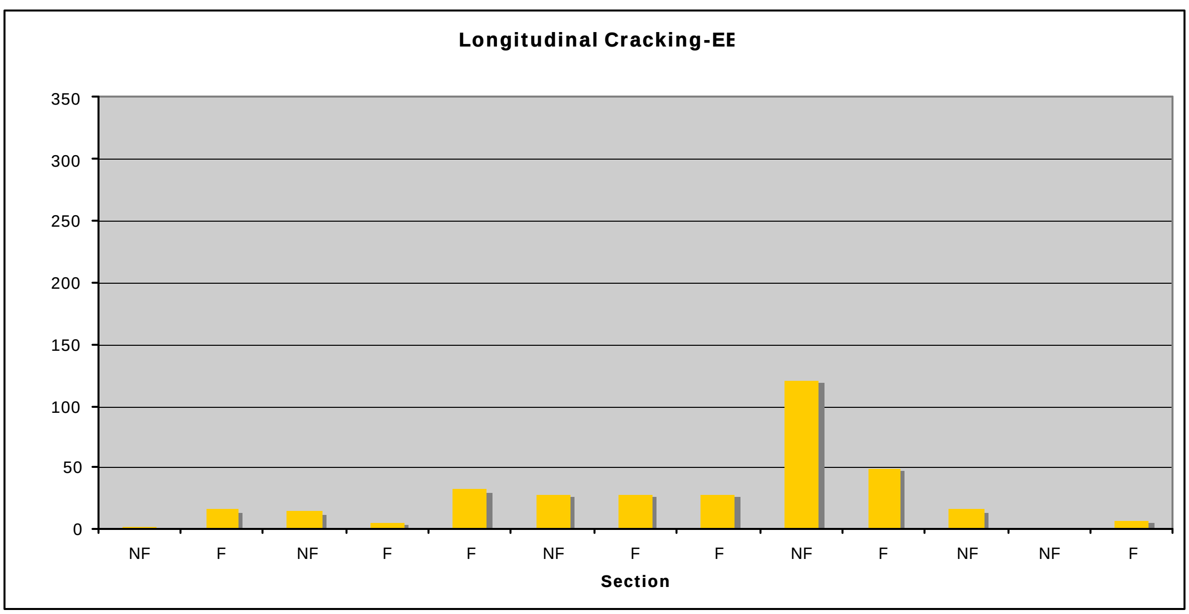

Figure 4: Longitudinal Cracking Eastbound US64

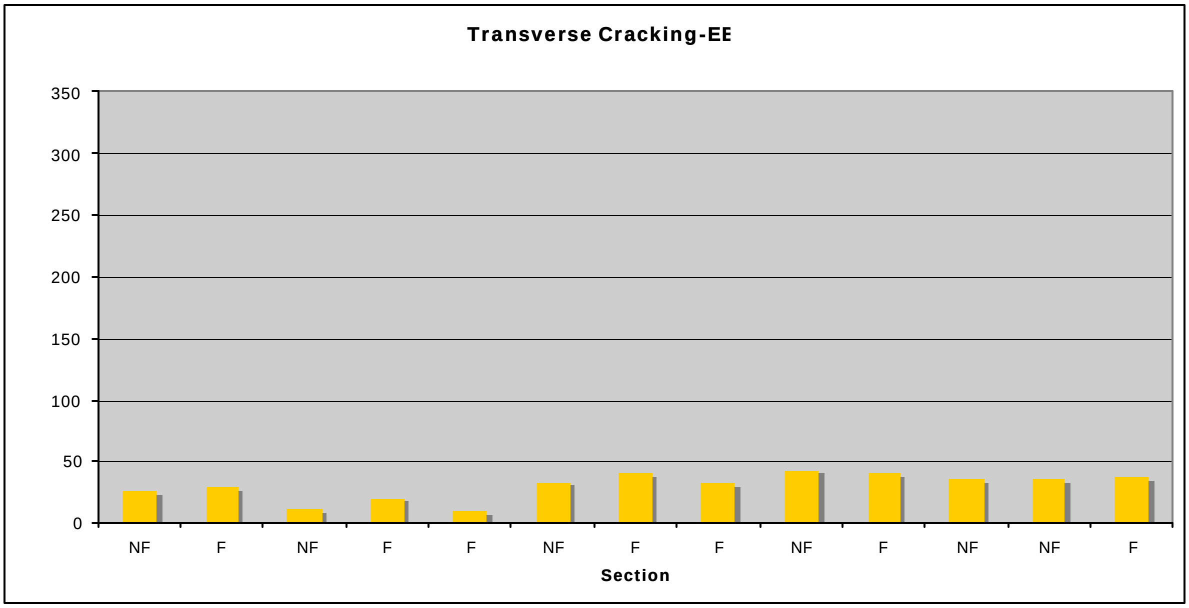

Figure 5: Transverse Cracking Eastbound US 64

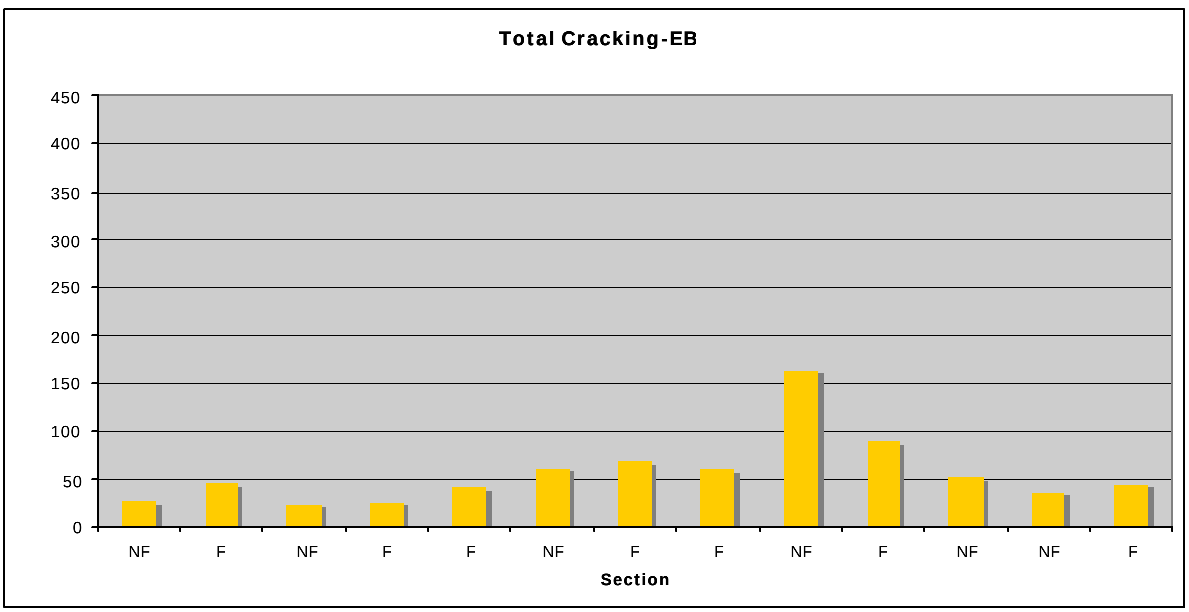

Figure 6: Total Cracking Eastbound US 64

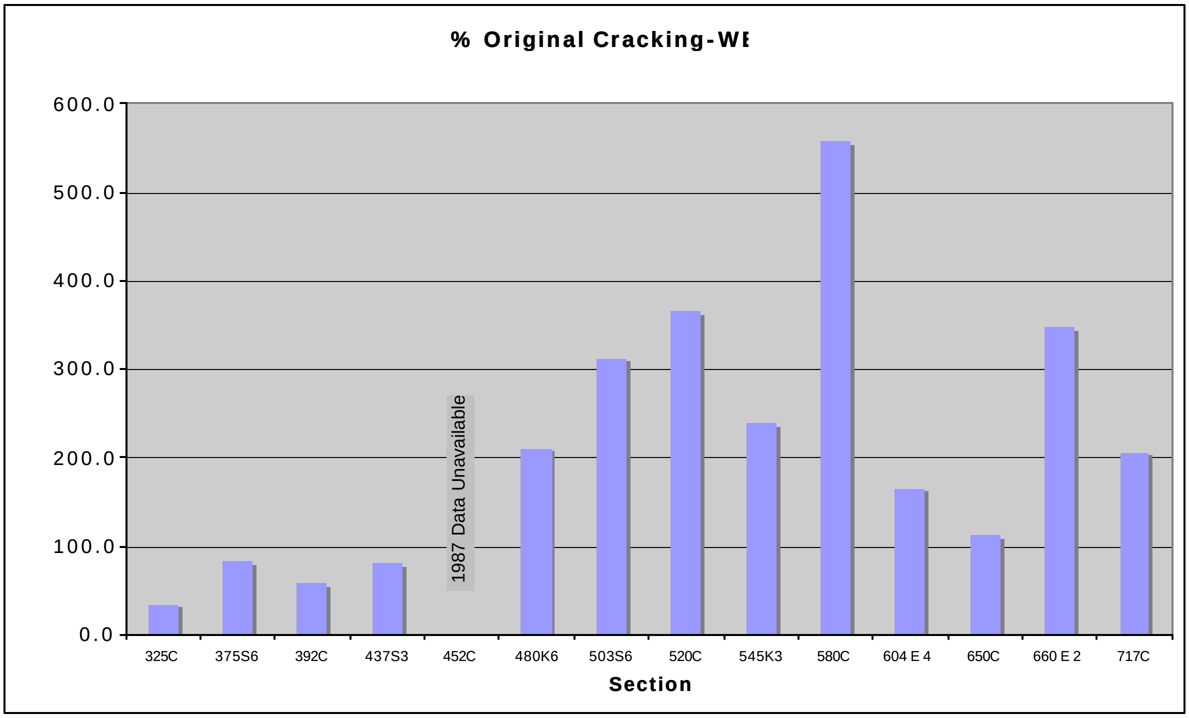

Figure 7: Percent of Cracking Before Construction Westbound US64

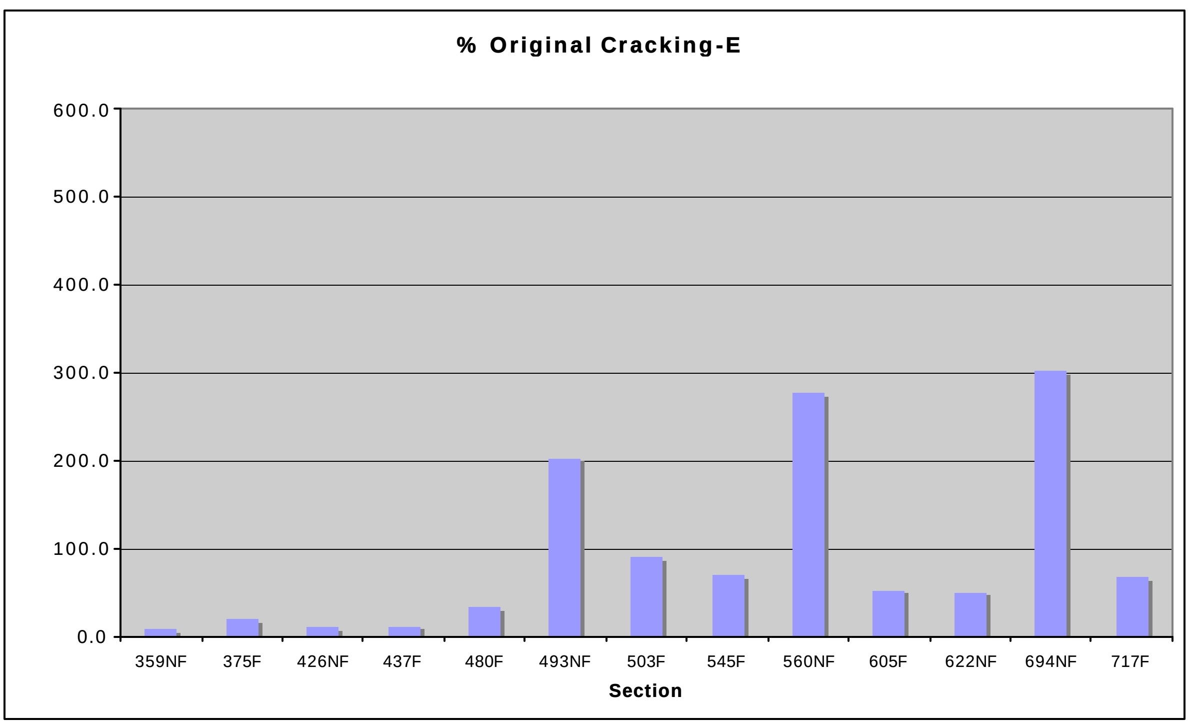

Figure 8: Percent of Cracking Before Construction Eastbound US64

Analysis

Westbound

The total cracking measured in the westbound lane is greater for the polymer modified test sections than the control sections as shown in Figure 3. Every control section had fewer total cracks, as well as fewer longitudinal and transverse cracks, than the corresponding polymer modified test sections as shown in Figures 1 through 3. When 2005 cracking is compared with cracking existing in 1987, a similar trend occurs. Five of the seven control sections outperformed corresponding polymer modified test sections with respect to the percentage of original cracks. Of the polymer modified test sections, two of the Styrelf sections performed somewhat poorer than corresponding control sections displaying approximately the same number of cracks in 2005 as were present in 1987. The other polymer modified sections performed much worse with an average of slightly less than two times the 1987 cracking for the Kraton test sections and an average of over two times the 1987 cracking for the Elvax modified sections.

Eastbound

No clear trend exists to conclude the geotextile interlayer performs better of worse than the control sections without fabric. However, the eastbound lane is performing significantly better than the westbound lane with only three of the thirteen sections displaying greater than 100 percent of the original total cracking. The average percent original cracking eastbound is 98 percent compared with 213 percent westbound.

Conclusions

1. The polymer modified test sections are performing poorer than corresponding control sections in the westbound lanes for five of seven control sections.

2. While the Styrelf sections are not performing as well as the corresponding control sections, they are performing better than the other polymer modified test sections. However, two Styrelf 6% sections were placed. One section is displaying approximately 80 percent of the original cracking while the second section is displaying 300 percent of the original cracking. Therefore, it is difficult to say without further data whether the Styrelf is performing better than the other polymer modifiers. Further evaluation of the pavement from these sections is planned to help provide this information.

3. The geotextile interlayer placed in the eastbound lanes is performing better than corresponding control sections in some cases, but not all. Further evaluation of the pavement is planned to help explain these differences.

4. The eastbound lane is performing significantly better than the westbound lane with less than half the cracking displayed in the westbound lane. The most

immediate and apparent reason for this difference is the source of the asphalt binder used. The westbound lane was fabricated with 120-150 asphalt from the Navajo refinery in Artesia, NM, while the eastbound lane was fabricated using 85-100 asphalt from the Diamond Shamrock refinery in Texas. The reason the 120-150 asphalt was used for the polymer modified test sections was because of incompatibility between the 85-100 binder and the polymers. Further research will be required to determine the reason for the poorer performance of the westbound lane.

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