Evaluation of Long-Term Field Performance of Cold In-Place Recycled Roads:

Field Distress Survey

Final Report
May 2007

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16. Abstract

Cold in-place recycling (CIR) has become an attractive method for rehabilitating asphalt roads that have good subgrade support and are suffering distress related to non-structural aging and cracking of the pavement layer. Although CIR is widely used, its use could be expanded if its performance were more predictable. Transportation officials have observed roads that were recycled under similar circumstances perform very differently for no clear reason. Moreover, a rational mix design has not yet been developed, design assumptions regarding the structural support of the CIR layer remain empirical and conservative, and there is no clear understanding of the cause-effect relationships between the choices made during the design/construction process and the resulting performance.

The objective of this project is to investigate these relationships, especially concerning the age of the recycled pavement, cumulative traffic volume, support conditions, aged engineering properties of the CIR materials, and road performance. Twenty-four CIR asphalt roads constructed in Iowa from 1986 to 2004 were studied: 18 were selected from a sample of roads studied in a previous research project (HR-392), and 6 were selected from newer CIR projects constructed after 1999.

This report describes the results of field distress surveys conducted on these CIR asphalt roads. The results indicate that the CIR roads performed better than expected, and the service life estimate has therefore been changed from 18 years to 25 years. Moreover, the predicted service life of the roads with good subgrade support was much longer than that of the roads with poor subgrade support. The results of this research can help identify changes that should be made with regard to design, material selection, and construction in order to improve the performance and cost-effectiveness of future recycled roads.

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EVALUATION OF LONG-TERM FIELD PERFORMANCE OF COLD IN-PLACE RECYCLED ROADS: FIELD DISTRESS SURVEY

Final Report
May 2007

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1. INTRODUCTION

1. 1. Problem Statement

Cold in-place recycling (CIR) is a popular rehabilitation tool in Iowa for both primary and secondary asphalt roads. The past performance of CIR roads has been good enough to justify the method's continued selection for rehabilitation projects. However, the method lacks the following:

- A rational mix design method that is generally accepted in Iowa
- An understanding of how the mix design and the construction methods influence the engineering properties of the materials
- An understanding of how the engineering properties change over time
- An understanding of how the engineering properties and the environment, traffic, and subgrade conditions influence the performance of the CIR pavement

When such gaps in understanding exist, there is an opportunity to improve the performance and cost effectiveness of the CIR rehabilitation technique. The goal of this research effort is to develop such improvements. After the results of this research project are disseminated, it is likely that better project selection, mix design, and construction methods will result in better road performance. These modifications to CIR techniques will also improve road condition and lengthen the time between rehabilitation cycles, benefiting road users with better pavements and taxpayers with greater cost effectiveness.

1. 2. Objectives

The objective of this research project is to develop an understanding of the following:

- How the engineering properties of CIR materials, the environment, traffic, and subgrade conditions influence the performance of the CIR pavement
- How the engineering properties of CIR materials change over time
- How the mix design and the construction methods influence the engineering properties of CIR materials

2. BACKGROUND

2. 1. Cold In-Place Recycled Roads

In 1986, cold in-place recycling first appeared in Iowa. The first CIR road was E50, located in Clinton county road near Andover (Jahren et al. 1998). The construction of CIR roads has since continued in Iowa. From 1996 to 1998, Jahren et al. (1998) investigated the performance of CIR pavements in Iowa and found that 18 test sections from 96 CIR roads were selected for a distress survey. Table 2.1 shows the list of test sections surveyed from 1996 to 1997.

Table 2.1. CIR Test Sections Surveyed in 1996 and 1997

County	Road	Year constructed	Year surveyed
Boone	198th Street	1988	1996
Boone	E-52	1991	1996
Butler	T-16	1993	1996
Calhoun	IA-175	1994	1997
Cerro Gordo	B-43	1989	1996
Cerro Gordo	South Shore Line	1990	1996
Clinton	E-50	1986	1996
Clinton	Z-30	1989	1996
Greene	IA-144	1990	1997
Guthrie	IA-4	1995	1997
Hardin	D-35	1992	1996
Muscatine	Y-14	1987	1996
Muscatine	G-28	1991	1996
Muscatine	F-70	1993	1996
Tama	E-66	1990	1996
Tama	V-18	1991	1996
Winnebago	R-34	1990	1996
Winnebago	R-60	1990	1996

The same 18 sections were surveyed again from 2004 to 2005 to determine their long-term performance. In addition, as shown in Table 2.2, 8 more sections were surveyed. Figure 2.1 shows how 22 out of these 26 test sections were classified in terms of age, level of traffic, and subgrade condition/drainage.

Table 2.2. CIR test sections surveyed in 2004 and 2005

No.	County	Road	Year constructed	Year surveyed
1	Boone	198th Street	1988	2004
2	Boone	E-52	1991	2004
3	Butler	T-16	1993	2004
4	Calhoun	IA-175	1994	2004
5	Cerro Gordo	B-43	1989	2004
6	Cerro Gordo	South Shore Line	1990	2005
7	Clinton	E-50	1986	2004
8	Clinton	Z-30	1989	2004
9	Greene	IA-144	1990	2004
10	Guthrie	IA-4	1995	2004
11	Hardin	D-35	1992	2004
12	Muscatine	Y-14	1987	2004
13	Muscatine	G-28	1991	2004
14	Muscatine	F-70	1993	2004
15	Tama	E-66	1990	2004
16	Tama	V-18	1991	2004
17	Winnebago	R-34	1990	2004
18	Winnebago	R-60	1990	2004
19	Carroll	N 58	2004	2005
20	Carroll	North of Breda	2002	2005
21	Delaware	US 20	2002	2005
22	Harrison	IA 44	2002	2005
23	Jackson	US 61	2002	2005
24	Montgomery	IA 48	2002	2005
25	Story	S 14	2003	2004
26	Story	S 27	2003	2004

		Good support (>Subgrade modulus of 5,000 psi)		**Poor support (< Subgrade modulus of 5,000 psi)**	
		Low traffic (0–800)	**High traffic (>800)**	**Low traffic (0–800)**	**High traffic (>800)**
Age	**Young (1999–)**	IA-44, Harrison	US-20, Delaware US-61, Jackson IA-48, Montgomery	N-58, Carroll N. of Breda, Carroll S-14, Story	S-27, Story
	Medium (1992–1998)	–	IA-175, Calhoun IA-4, Guthrie F-70, Muscatine	V-18, Tama E-52, Boone T-16, Butler	G-28, Muscatine D-35, Hardin
	Old (1986 1991)	R-34, Winnebago B-43, Cerro Gordo R-60, Winnebago	S.S.L., Cerro Gordo Z-30, Clinton E-66, Tama	198th St., Boone E-50,Clinton	Y-14, Muscatine IA-144, Greene

Figure 2.1. Twenty-two test sections classified by age, traffic, and subgrade support/drainage

2. 2. Distress Data Collection

To collect surface distress data between 2004 and 2005, an automated image collection system (AICS) was adopted, in contrast to the walking survey used to collect data between 1996 and 1997. As shown in Figure 2.2, the AICS is composed of an off-the-shelf digital area scan video camera mounted on a vehicle, a distance measuring instrument (DMI), and a portable computer with an image processing board. This digital area scan camera can capture an image with a 776×582 pixel resolution at 0.001 seconds of exposure time.

The DMI first provides a distance signal that allows the computer controller to capture an image at a predetermined distance. The digital video camera, mounted on top of a vehicle at approximately 9 ft. (2.7 m) from the ground, then captures an image of an area 130 in. (3.4 m) wide by 100 in. (2.5 m) long on the pavement surface. As a result, each pixel represents an approximately 5 mm x 5 mm area on the pavement surface. However, both edges of the image are slightly distorted when a wide-angle camera lens is used to cover the full lane width of 130 in. (3.4 m).

The AICS can capture digital images at a speed of up to 50 mph in daylight and store the images captured at predetermined intervals using a distance signal from the DMI. To measure rut depth, a new portable rutting device (PRD) has been developed to measure rutting in both inner and outer wheel paths at every 50 ft. along each 1,500 ft. long test section.

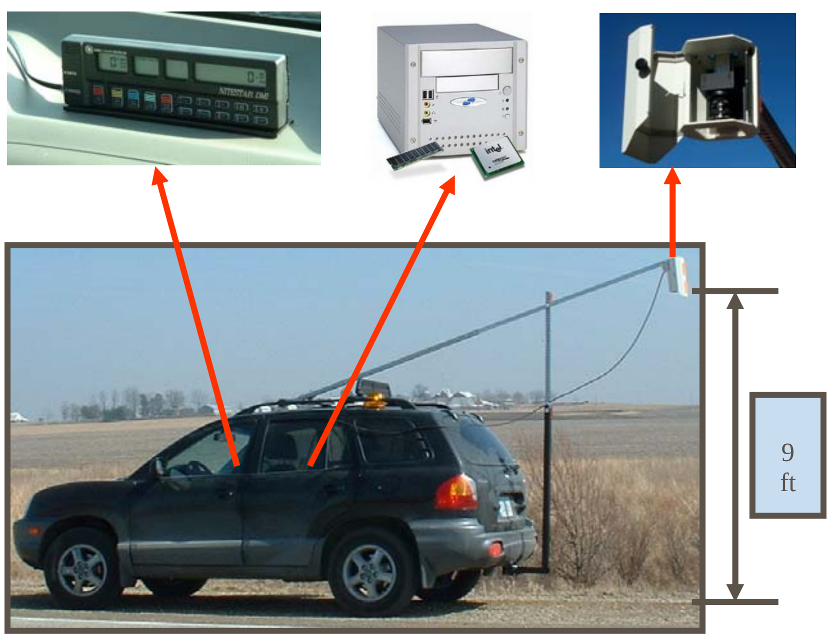
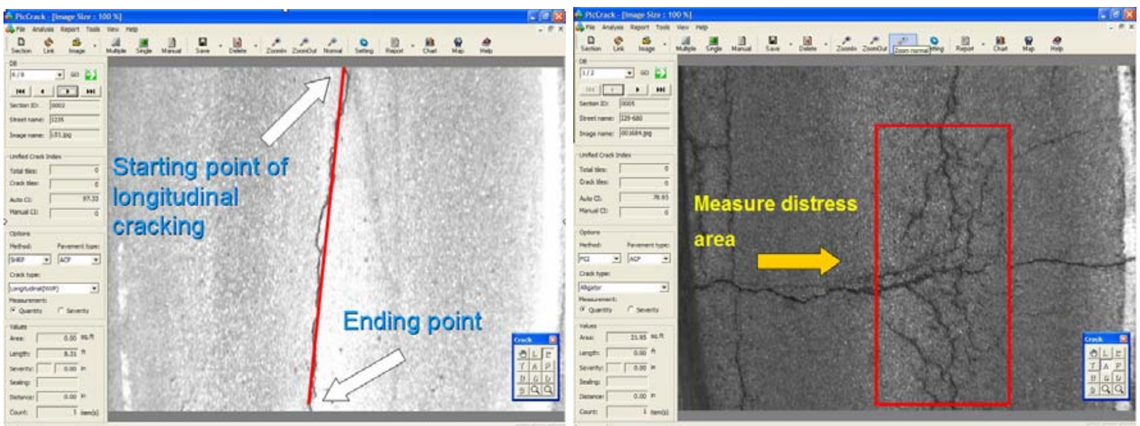


Figure 2.2. Configuration of automated image collection system

2. 3. Distress Data Analysis

To measure the length and area of each pavement distress, a manual image analysis system (MIAS) was used on the images collected by the AICS (see Lee and Kim 2005). The MIAS allows an operator to measure the extent and severity of various types of distress from a computer screen. As shown in Figure 2.3(a), an operator can measure the length of a crack by tracing the crack with a mouse cursor on a computer screen. The user holds down the left mouse button and drags the mouse from the starting point of the crack to its ending point. In order to measure the extent of alligator cracking, as shown in Figure 2.3(b), the operator can draw a rectangle along the boundary of the cracked area. The MIAS then automatically computes the extent of the alligator crack as measured in the field. To measure the severity of cracking, the image is zoomed to a predetermined level and the operator measures the crack width using a mouse. The information window also displays necessary information, such as a full path of the image file, location information from the DMI, and the actual dimensions of pavement surface.



(a) Length of longitudinal crack **(b) Area of alligator cracking**

Figure 2.3. MIAS screen shots demonstrating the manual crack measuring process

3. RESULTS AND DISCUSSION

Pavement distresses on the CIR test sections listed above were objectively measured using AICS and MIAS, and smoothness was subjectively evaluated by two individuals from the moving vehicle. Both pavement condition index (PCI) and pavement serviceability index (PSI) values were calculated following the procedure used in previous research (Jahren et al. 1998; also see Shahin 2007), and the results are summarized in Tables 3.1 and 3.2.

Table 3.1 provides the PCI value, PSI value, and the average of the PCI and PSI values for the 18 test sections measured during the first and second surveys. As expected, and as Table 3.1 shows, most of the test sections evaluated in 2004 and 2005 exhibited a lower average value of PSI and PCI than those surveyed in 1996 and 1997, apart from two test sections in Tama County, E 66 and V18. Four test sections exhibited higher PSI values, whereas no test sections exhibited higher PCI values. These discrepancies could be attributed to the subjective nature of measuring PSI using a windshield survey. Because of these discrepancies, the performance analysis was conducted based on the PCI values alone, without the PSI values. The results of the performance analysis are presented in the following section.

Table 3.1. Performance data for 18 oldest test sections from the 1st and 2nd surveys

Road	Subgrade modulus (ksi)	First survey					Second survey				
		Traffic	Age	PCI	PSI	(PCI+PSI) /2	Traffic	Age	PCI	PSI	(PCI+PSI) /2
IA4	19.81	820	2	100	90	95	1850	10	98	78	88
IA144	13.16	1110	7	62	58	60	1770	15	54	50	52
IA175	22.05	1920	3	100	81	91	1560	11	63	56	60
Y14	13.03	990	9	86	61	74	1490	18	60	43	52
F70	23.78	950	3	100	82	91	1250	12	92	75	84
E66	11.9	1080	6	94	61	78	1170	15	93	71	82
SSL	23.53	600	6	81	61	71	1140	15	54	66	60
G28	19.96	940	5	98	73	86	1100	14	73	51	62
D35	10.69	665	4	85	65	75	930	13	78	63	71
Z30	18.5	850	7	99	64	82	890	16	70	51	61
T16	10.39	470	3	100	81	91	610	12	96	85	91
V18	16.7	550	5	100	70	85	570	14	97	74	86
R60	19.86	340	6	72	63	68	550	15	70	45	58
E50	13.21	520	10	81	51	66	540	19	48	51	50
B43	22.21	570	7	82	69	76	450	16	61	45	53
R34	15.94	620	6	90	63	77	400	15	89	59	74
E52	8.94	290	5	95	73	84	390	14	85	68	77
198th St.	12.63	300	8	71	59	65	130	17	54	59	57

Table 3.2. Performance data for the eight newest test sections from the 2nd survey

Road	Subgrade modulus (ksi)	Traffic (AADT)	Age	PCI	PSI	(PCI+PSI)/2
US61	32.61	6200	3	87	88	88
IA48	18.93	1980	3	100	95	98
S27	12.11	1000	1	100	100	100
US20	46.12	900	3	91	88	90
IA44	19.53	770	3	100	90	95
S14	14.04	740	1	100	100	100
N58	15.78	340	1	100	100	100
N. of Breda	11.58	190	3	99	88	94

3. 1. Pavement Performance Based on PCI and PSI

In Figure 3.1, the averages of the PSI and PCI values for each road, based on the two surveys performed on the 18 oldest sections and the 8 newest sections, are plotted against pavement age. As the figure shows, the regression equation, Y = - 2.5545X + 100 (R^2 = 0.7887), predicts that the service life of a CIR road would be between 17.9 and 23.5 years. It is assumed that the service life of the road ends when the average of the PCI and PSI values indicates a fair condition (a range from 55 to 40), and it is predicted that the roads will reach a value of 55 in 17.9 years and a value of 40 in 23.5 years.

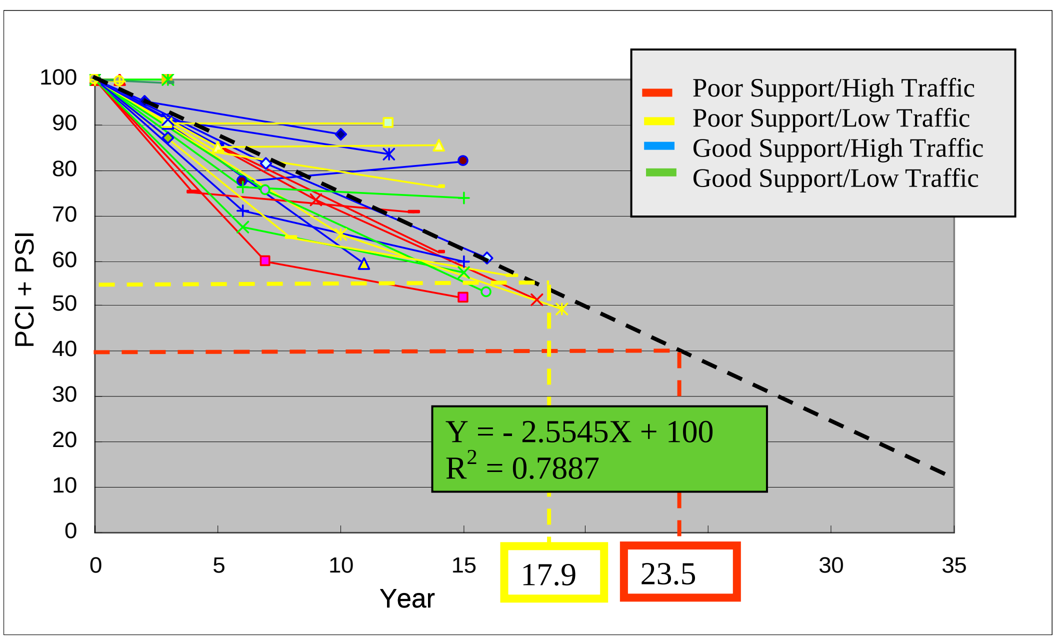


Figure 3.1. Performance curve of the average of PCI and PSI based on distress surveys

In Figure 3.2, the average of the PCI and PSI values collected from the sections with poor subgrade support are plotted against age. As the figure shows, the regression equation, Y = -

2.5156X + 100 (R^2 = 0.7808), predicts that the service life of a CIR road would be between 17.6 and 23.5 years. It is assumed that the service life of the road ends when the average of the PCI and PSI values indicates a fair condition (a range from 55 to 40), and it is predicted that the roads will reach a value of 55 in 17.6 years and a value of 40 in 23.5 years. As shown in Figure 3.2, the test sections with a high traffic volume seemed to deteriorate faster than those with a low traffic volume.

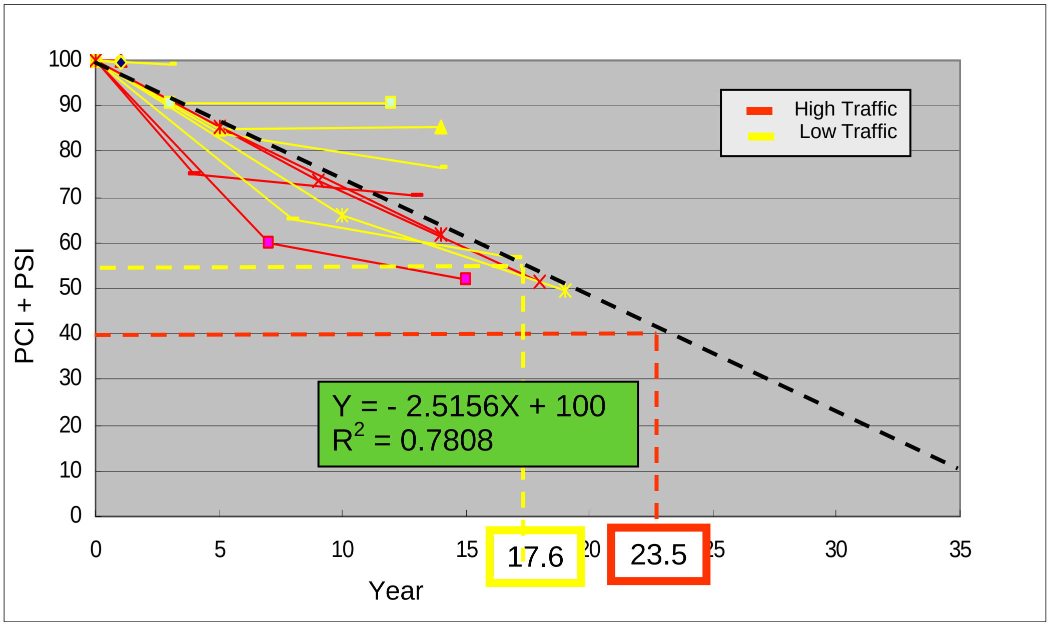


Figure 3.2. Performance curve of test sections with poor subgrade support

In Figure 3.3, the average of the PCI and PSI values collected from the sections with good subgrade support are plotted against age. As the figure shows, the regression equation, Y = -2.6017X + 100 (R^2 = 0.58015), predicts that the service life of a CIR road would be between 17.3 and 23.1 years. It is assumed that the service life of the road ends when the average of the PCI and PSI values indicates a fair condition (a range from 55 to 40), and it is predicted that the roads will reach a value of 55 in 17.3 years and a value of 40 in 23.1 years. As shown in Figure 3.3, the test sections with a high traffic volume seemed to deteriorate faster than those with a low traffic volume. It seems significant that the performance of the test sections with good subgrade support is similar to that of test sections with poor subgrade support.

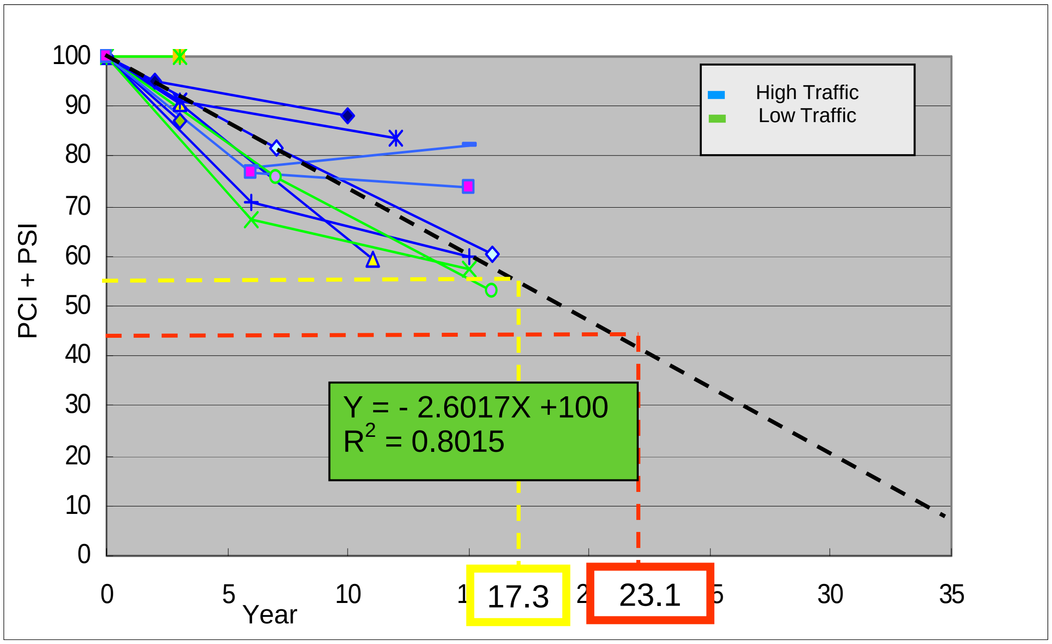


Figure 3.3. Performance curve of test sections with good subgrade support

In Figure 3.4, the average of the PCI and PSI values collected from the sections with a high traffic volume are plotted against age. As the figure shows, the regression equation, Y = -2.7059X + 100 (R^2 = 0.8158), predicts that the service life of a CIR road would be between 16.6 and 22.2 years. It is assumed that the service life of the road ends when the average of the PCI and PSI values indicates a fair condition (a range from 55 to 40), and it is predicted that the roads will reach a value of 55 in 16.6 years and a value of 40 in 22.2 years. As shown in Figure 3.4, the test sections with poor subgrade support seemed to deteriorate faster than those with good subgrade support.

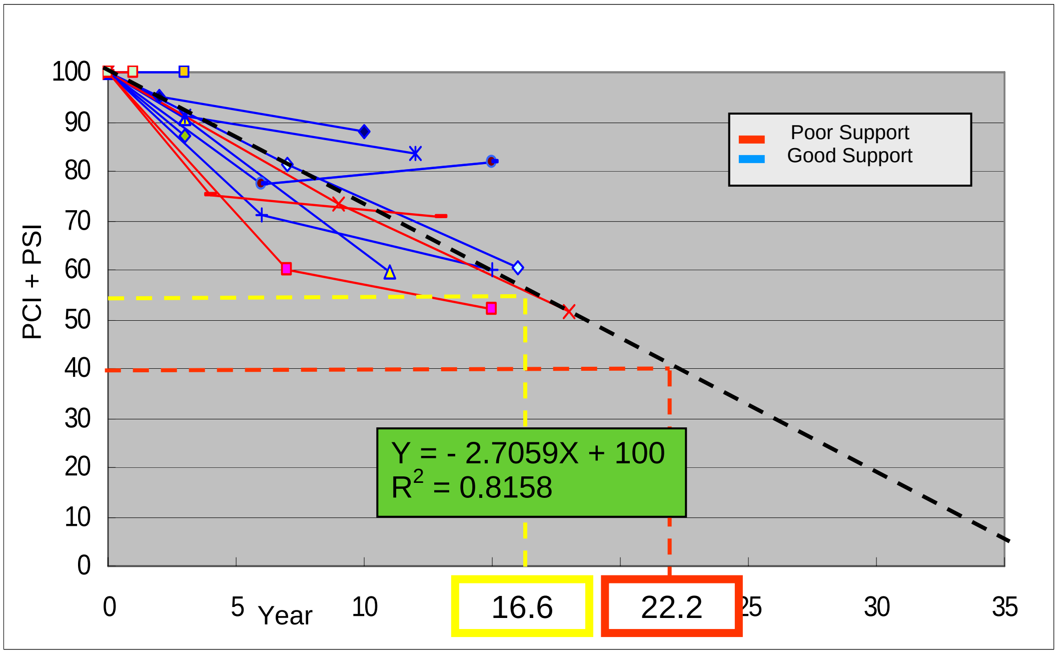


Figure 3.4. Performance curve of test sections with high traffic levels

The average PCI + PSI values collected from the sections with a low traffic volume are plotted against age in Figure 3.5. As the figure shows, the regression equation, Y = - 2.3989X + 100 (R^2 = 0.7708), predicts that the service life of a CIR road would be between 18.8 and 25 years. It is assumed that the service life of the road ends when the average of the PCI and PSI values indicates a fair condition (a range from 55 to 40), and it is predicted that the roads will reach a value of 55 in 18.8 years and a value of 40 in 25 years. It is interesting to note that the service life of the test sections under low traffic volumes is slightly longer than that of the test sections with high traffic volumes.

Figure 3.5 also shows that, contrary to common sense, the test sections with good subgrade support seemed to deteriorate faster than those with poor subgrade support. It can be postulated that, under low traffic volumes, subgrade support has no influence on the performance of CIR pavements.

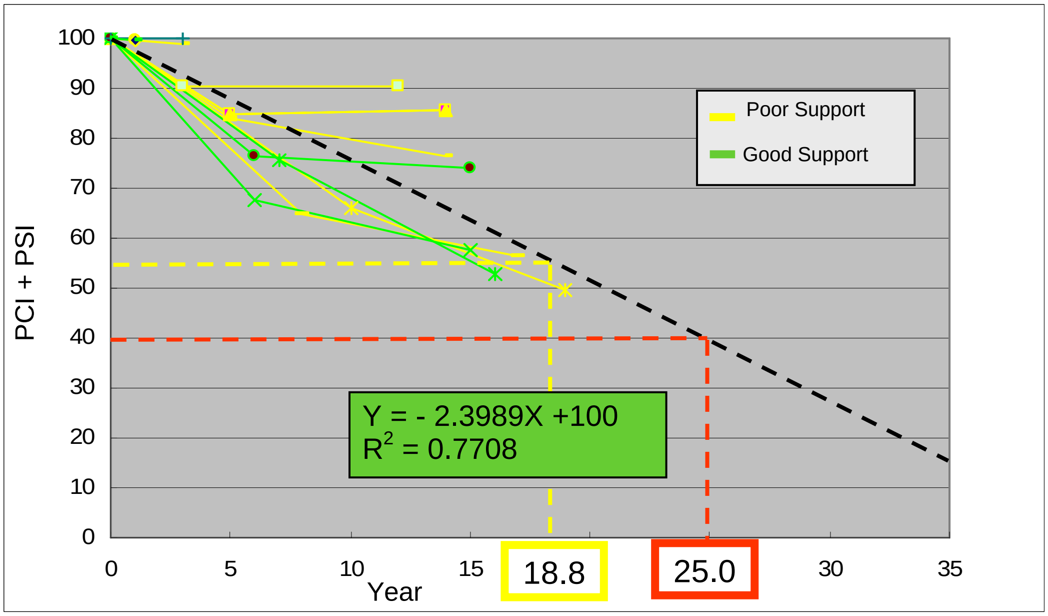


Figure 3.5. Performance curve of test sections with low traffic levels

3. 2. Pavement Performance Based on PCI

In Figure 3.6, the PCI values collected from the two surveys performed on the 18 oldest sections and the 8 newest sections are plotted against the pavement age. As the figure shows, the regression equation, $Y = -0.0486X^2 - 1.155X + 100$ ($R^2 = 0.6158$), predicts that the PCI of the CIR roads would indicate a fair condition (PCI ranging from 55 to 40) between 21 and 25 years, respectively. Although the R^2 value is somewhat less than the one based on the average of the PCI and PSI values, the predicted service life is slightly higher.

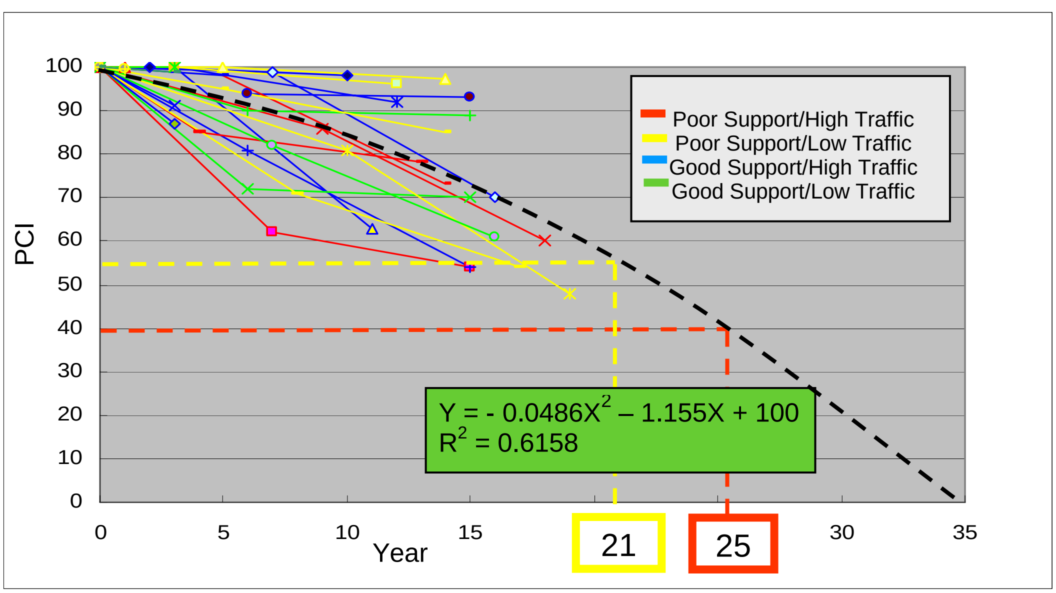


Figure 3.6. PCI performance curve based on distress surveys

In Figure 3.7, the PCI values collected from the sections with poor subgrade support are plotted against age. As the figure shows, the regression equation, Y = - 0.0776X^2 – 0.9153X +100 (R^2 = 0.7039), predicts that the PCI of the CIR roads would indicate a fair condition (PCI ranging from 55 to 40) between 18 and 22 years, respectively. These values are very similar to the ones based on the average of the PCI and PSI values. As shown in Figure 3.7, the test sections with a high traffic volume seemed to deteriorate faster than those with a low traffic volume.

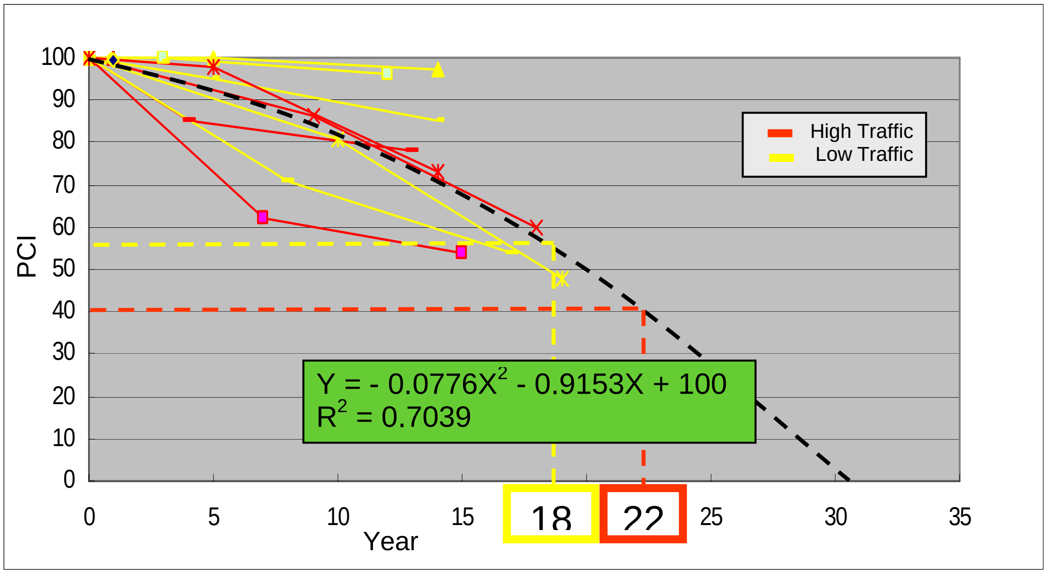


Figure 3.7. PCI performance curve of test sections with poor subgrade support

In Figure 3.8, the PCI values collected from the sections with good subgrade support are plotted against age. As the figure shows, the regression equation, Y = - 0.036X^2 – 1.6969X +100 (R^2 = 0.5743), predicts that the PCI of the CIR roads would indicate a fair condition (PCI ranging from 55 to 40) between 26 and 34 years, respectively. It is interesting to note that the predicted service life of the test sections with good subgrade support is much longer than that of the test sections with poor subgrade support. Figure 3.8 shows that, although there are limited number of data points, the test sections with a low traffic volume seemed to deteriorate faster than those with a high traffic volume. It can be postulated that the performance of pavements with good subgrade support is not affected by the traffic level.

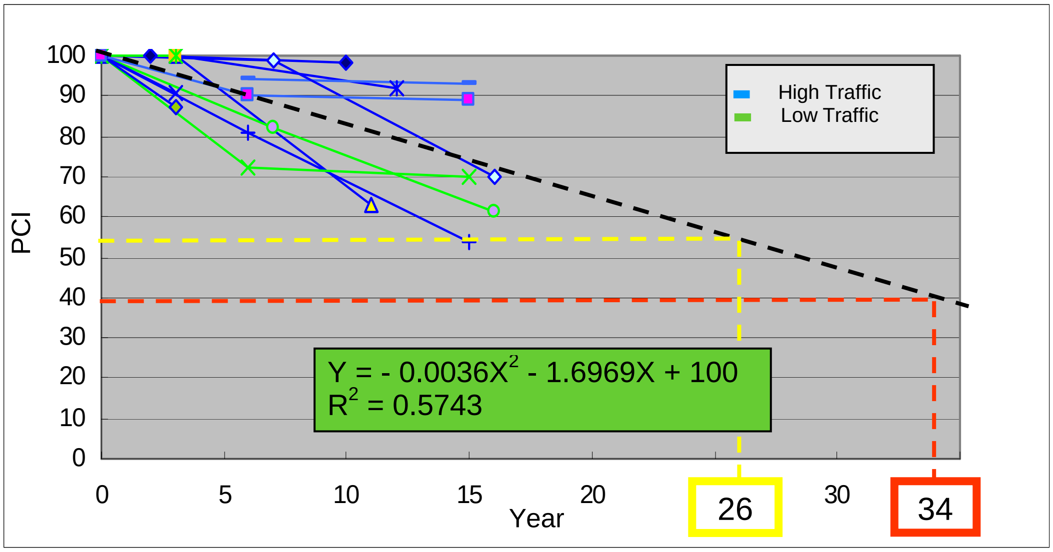


Figure 3.8. PCI Performance curve of test sections with good subgrade support

In Figure 3.9, the PCI values collected from the sections with a high traffic volume are plotted against age. As the figure shows, the regression equation, Y = - $0.0367X^2$ – 1.4929X +100 (R^2 = 0.6394), predicts that the PCI of the CIR roads would indicate a fair condition (PCI ranging from 55 to 40) between 21 and 25 years, respectively. As shown in Figure 3.9, the test sections with poor subgrade support seemed to deteriorate faster than those with good subgrade support.

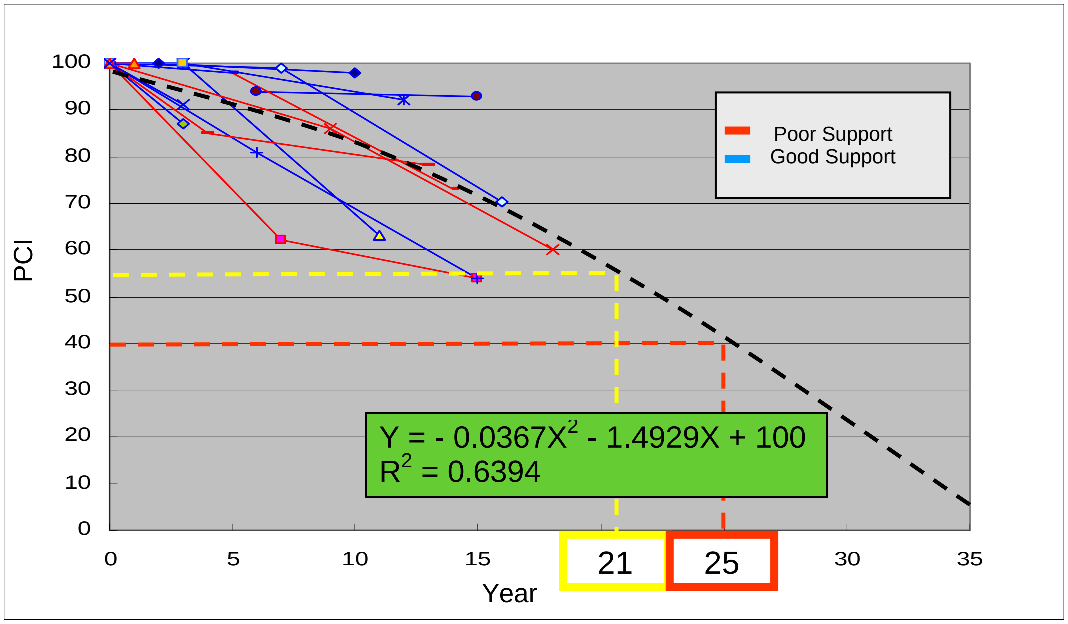


Figure 3.9. PCI performance curve of test sections with high traffic levels

In Figure 3.10, the PCI values collected from the sections with a low traffic volume are plotted against age. As the figure shows, the regression equation, $Y = -0.0737X^2 - 0.7605X + 100$ ($R^2 = 0.6609$), predicts that the PCI of the CIR roads would indicate a fair condition (PCI ranging from 55 to 40) between 20 and 25 years, respectively. It is interesting to note that the service life of the test sections under a low traffic volume is very similar to that of the test sections with a high traffic volume.

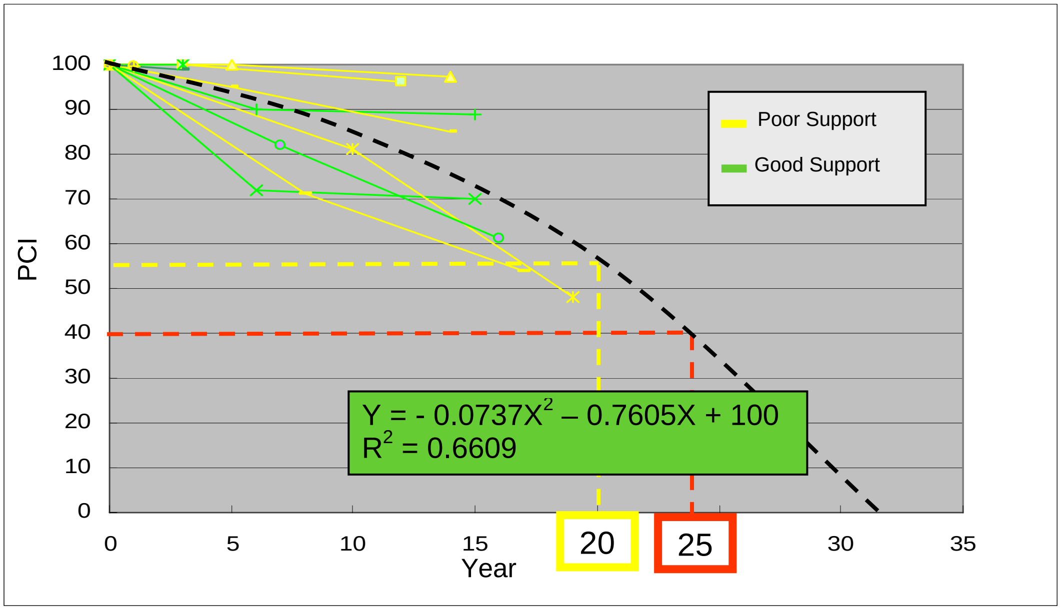


Figure 3.10. PCI performance curve of test sections with low traffic levels

3. 3. Pavement Performance Based on Individual Distress Types

To model the deterioration behavior of individual distresses, individual distress values were plotted against pavement age. Tables 3.3 and 3.4 summarize the individual distress values collected from the 18 oldest test sections and the 8 newest test sections from the two surveys. As the tables show, most test sections exhibited a higher amount of distress over time in nearly all categories, except in block cracking.

The length of longitudinal cracking in most sections increased over time, except for the 198th street section, where longitudinal cracking length decreased from 27 ft. to 21 ft. per 100 ft. In the same street, however, the amount of alligator cracking increased from 50 ft^2 to 240 ft^2 per 100 ft., and the amount of transverse cracking increased from 5 ft. to 24 ft. per 100 ft. Thus, it can be postulated that longitudinal cracking might have become alligator cracking.

The length of transverse cracking in most sections increased over time, except for the E66 section, where transverse cracking length decreased from 15 ft. to 13 ft. per 100 ft. Alligator cracking also increased over time in all sections, whereas block cracking often decreased over time. For the SSL street section, for example, the area of block cracking decreased from 14 ft^2 to

0 ft^2 per 100 ft., while alligator cracking considerably increased by 149 ft^2 per 100 ft. It can be postulated that block cracking might have become alligator cracking over time.

For the G28 road section, block cracking decreased by 10 ft^2 per 100 ft. without an increase in alligator cracking, although longitudinal and transverse cracking increased significantly. This discrepancy may be attributed to a possible error in measuring block cracking using MIAS, because an MIAS user may have determined that the pavement image exhibited a series of longitudinal and transverse cracks rather than block cracking.

The area of rutting also increased in most sections, except in B43.

Table 3.3. Distress data of 18 oldest test sections from the 1st and 2nd surveys

Road	Longitudinal (ft/100 ft.)		Transverse (ft/100 ft.)		Alligator (ft^2/100 ft.)		Block (ft^2/100 ft.)	
	First	Second	First	Second	First	Second	First	Second
IA4	0	0	6	25	0	0	0	0
IA144	33	61	64	109	0	385	0	13
IA175	0	47	10	22	0	191	0	6
Y14	34	173	70	248	0	24	0	274
F70	0	34	0	7	0	0	0	0
E66	0	4	15	13	0	0	0	0
SSL	31	31	44	49	0	149	14	0
G28	8	257	21	73	0	0	19	9
D35	0	37	83	85	0	30	180	0
Z30	0	452	16	61	0	30	0	43
T16	0	1	8	11	0	0	0	0
V18	0	1	9	12	0	0	0	0
R60	0	0	0	0	0	0	2200	2200
E50	16	172	51	64	0	136	0	0
B43	105	162	41	167	0	0	232	14
R34	2	31	89	64	0	0	0	0
E52	0	42	19	25	0	0	0	0
198th St.	27	21	5	24	50	240	0	0

Table 3.3. Distress data of 18 oldest test sections from the 1st and 2nd surveys (continued)

Road	Rutting (ft^2/100 ft.)		Edge cracking (ft/100 ft.)		Patching (ft^2/100 ft.)	
	First	Second	First	Second	First	Second
IA4	0	0	0	0	0	0
IA144	60	65	0	36	0	0
IA175	0	55	0	4	0	0
Y14	25	45	0	5	0	153
F70	0	5	0	4	0	0
E66	0	5	0	0	0	0
SSL	5	0	0	0	0	2
G28	0	10	0	1	0	65
D35	5	20	0	4	0	0
Z30	0	0	0	0	0	0
T16	0	0	0	32	0	0
V18	0	0	0	4	0	0
R60	0	10	0	0	0	0
E50	30	60	0	42	0	84
B43	25	5	0	0	0	0
R34	0	10	0	0	0	0
E52	0	0	28	31	0	0
198th St.	80	140	4	4	0	0

Table 3.4. Distress data of the 8 newest test sections from the 2nd survey

Road	Longitudinal (ft/100 ft.)	Transverse (ft/100 ft.)	Alligator (ft^2/100 ft.)	Block (ft^2/100 ft.)	Rutting (ft^2/100 ft.)	Edge (ft/100 ft.)	Patching (ft^2/100 ft.)
US61	0	0	2	0	35	0	0
IA48	0	0	0	0	0	0	0
S27	0	0	0	0	0	0	0
US20	52	0	10	0	0	0	0
IA44	0	1	0	0	0	0	0
S14	0	0	0	0	0	0	0
N58	0	0	0	0	0	0	0
N. of Breda	0	7	0	0	0	3	0

In Figures 3.11 through 3.17, pavement age is plotted against individual distresses, longitudinal cracking, transverse cracking, alligator cracking, block cracking, rutting, edge cracking, and patching, respectively. These figures are also categorized by a combination of subgrade support levels and traffic volumes. As discussed above, longitudinal and alligator cracking increased in most sections over time, while transverse cracking changed little. As shown in Figure 3.14, block cracking decreased in some pavement sections due to its possible transformation into alligator cracking and/or its rather vague definition. As can be seen from Figures 3.15, 3.16, and 3.17, rutting, edge cracking, and patching seemed to increase predominantly in the sections with poor subgrade support.

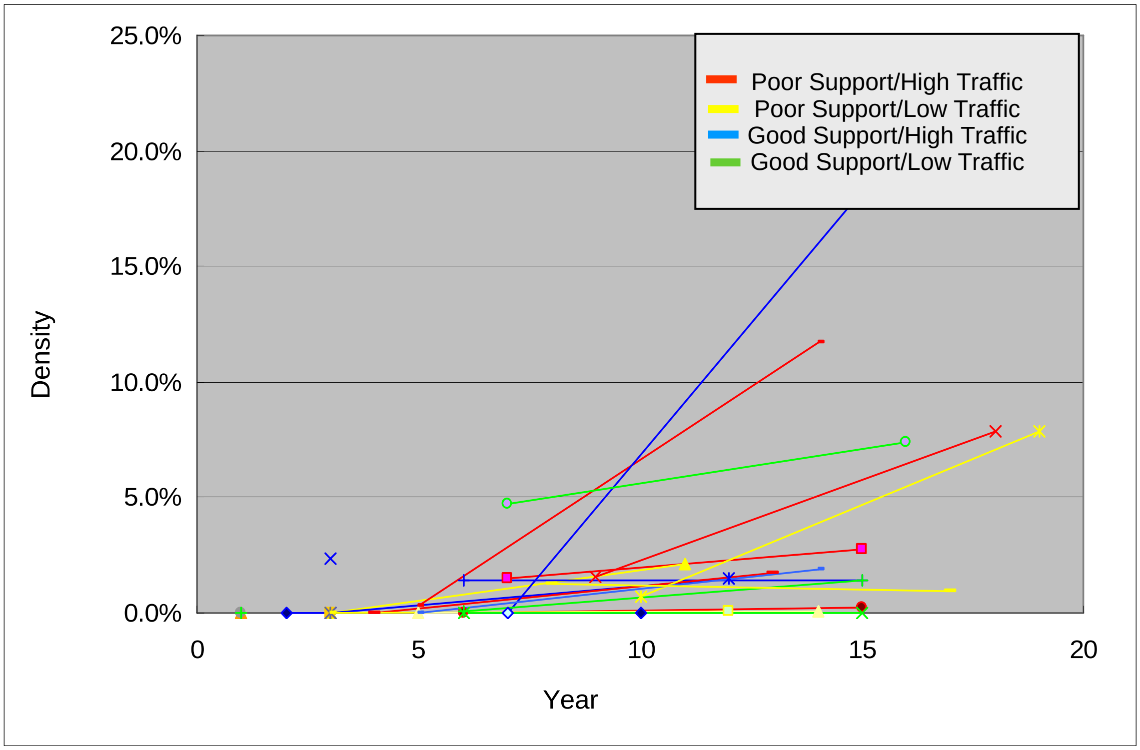


Figure 3.11. Changes in longitudinal cracking density over time

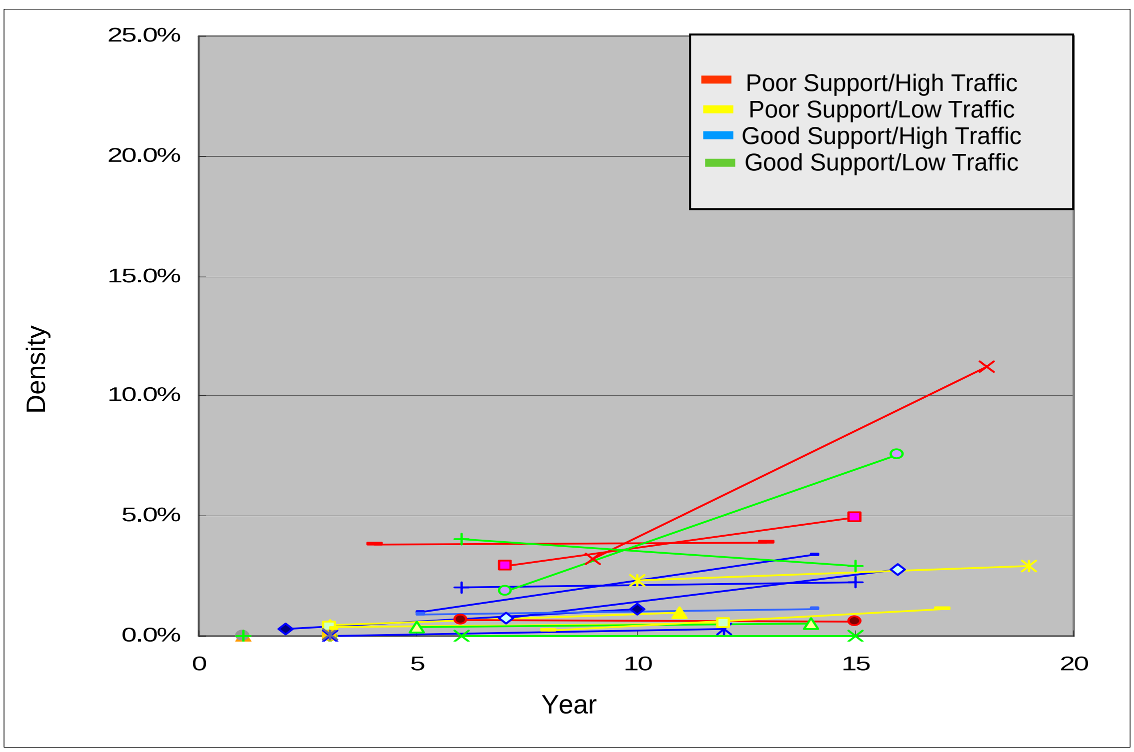


Figure 3.12 Changes in transverse cracking density over time

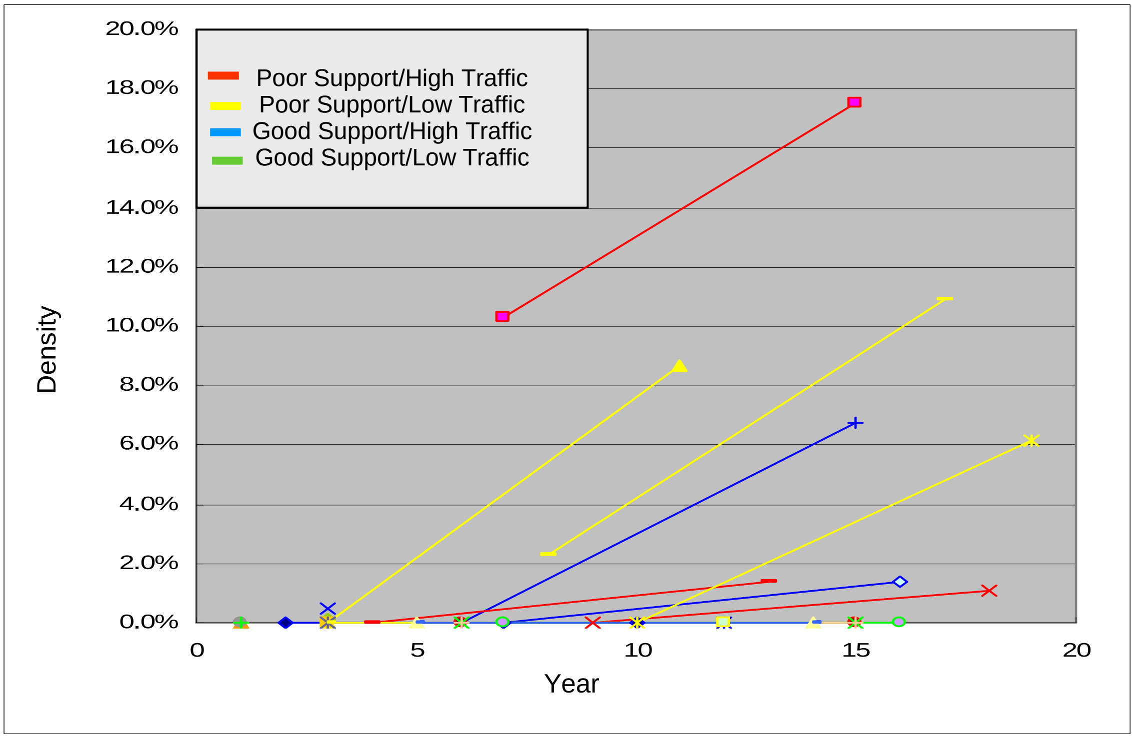


Figure 3.13. Changes in alligator cracking density over time

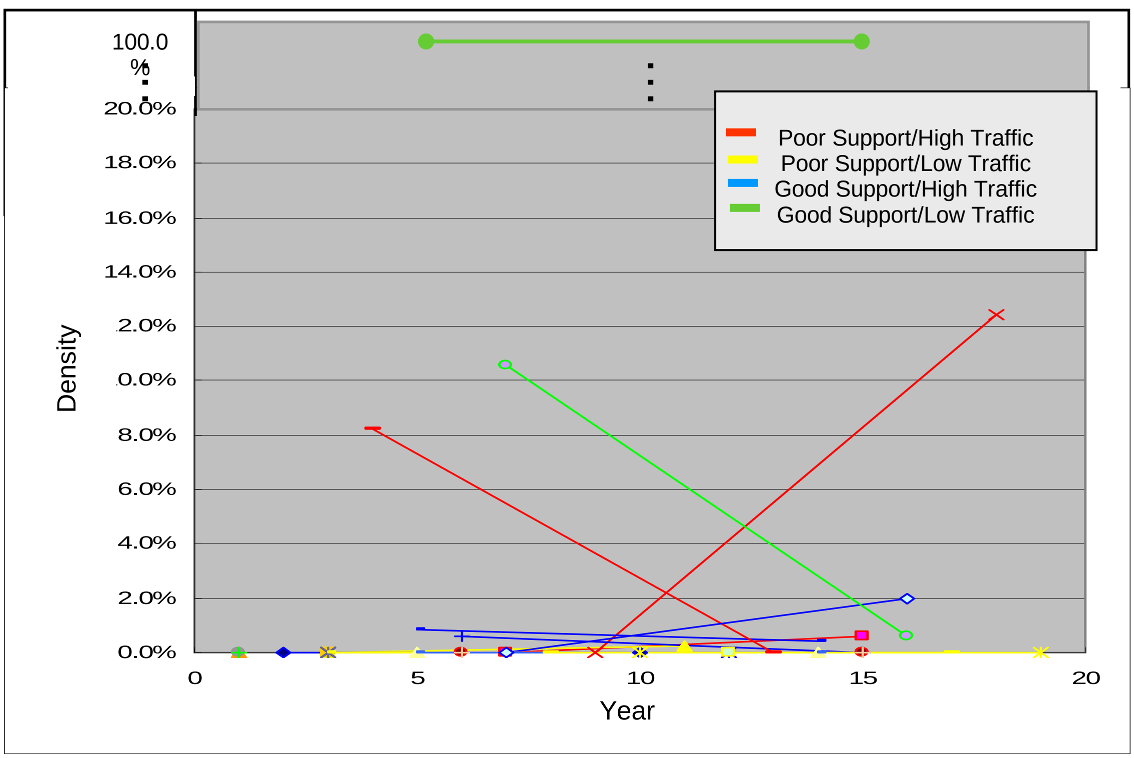


Figure 3.14. Changes in block cracking density over time

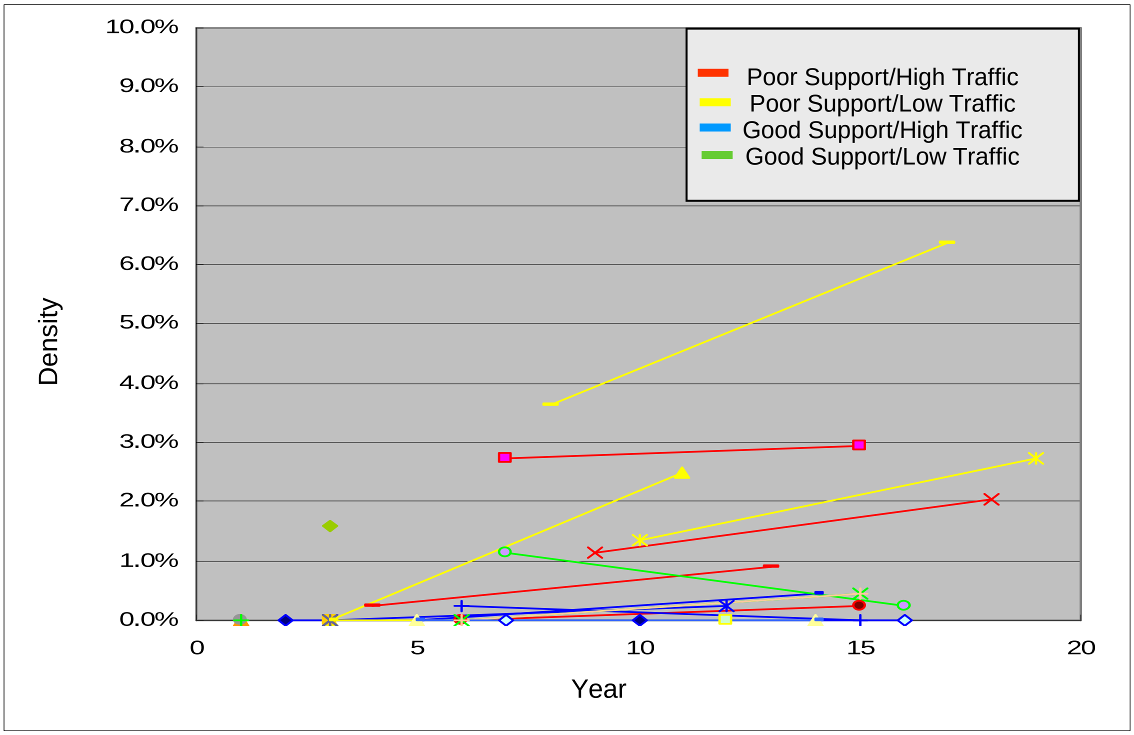


Figure 3.15. Changes in rutting density over time

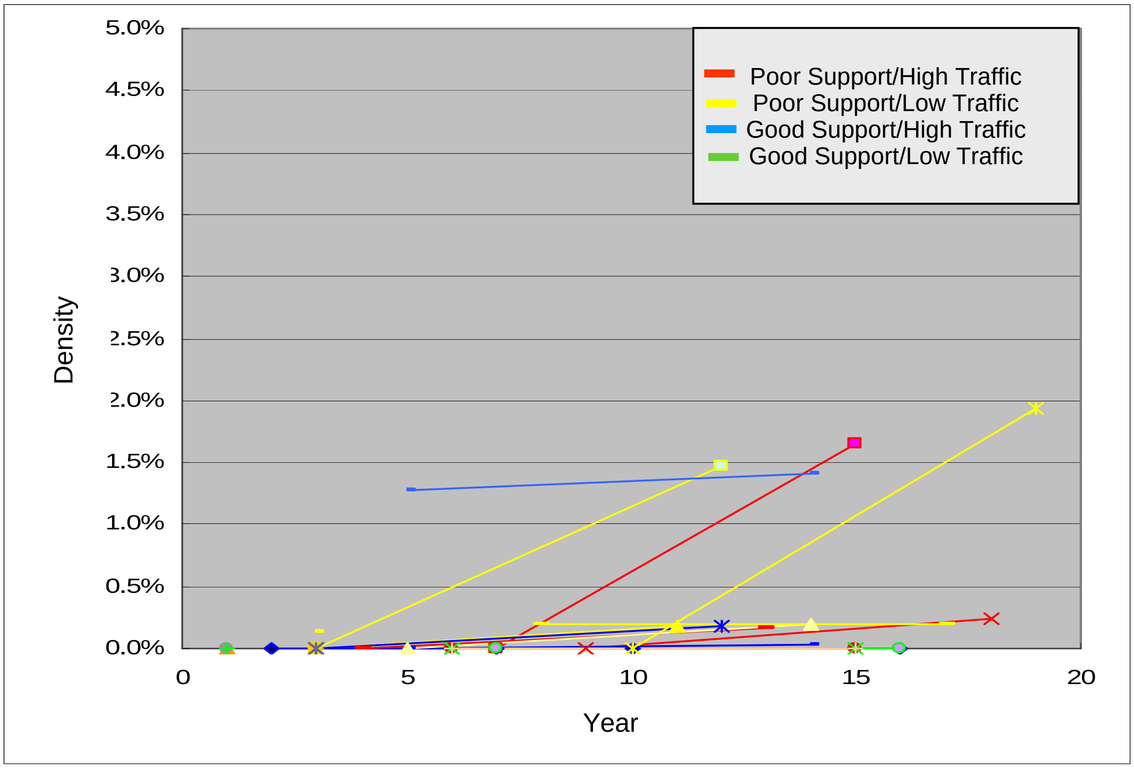


Figure 3.16. Changes in edge cracking density over time

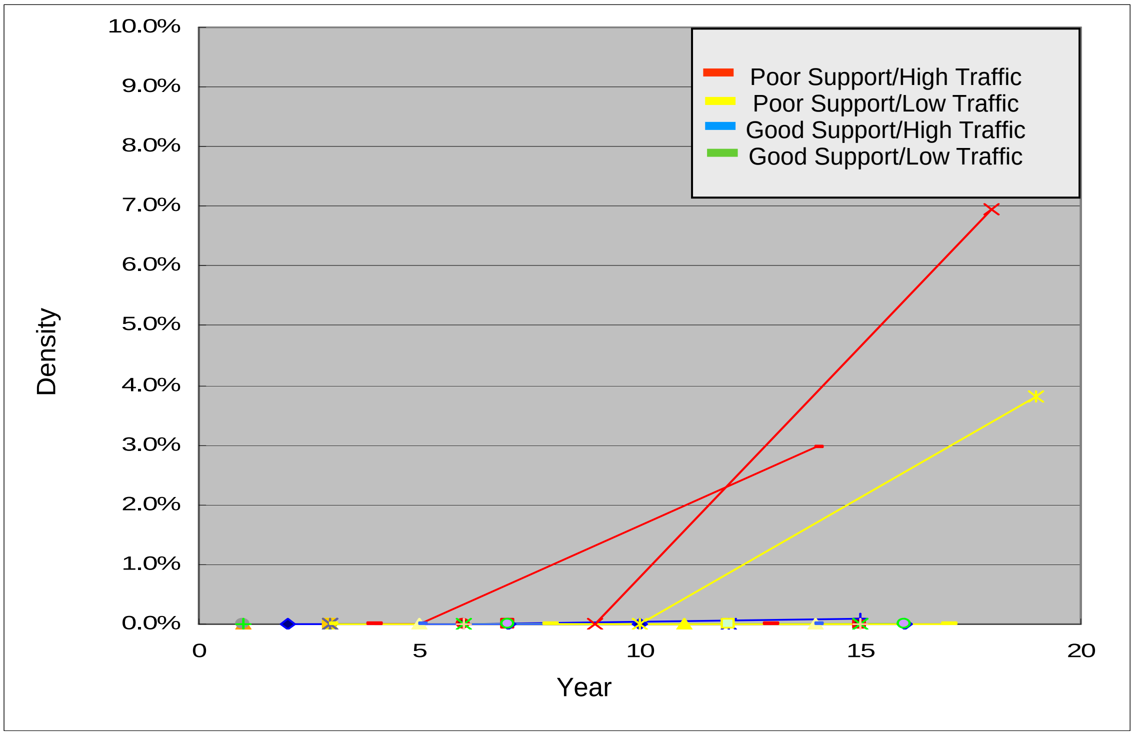


Figure 3.17. Changes in patching density over time

4. SUMMARY AND CONCLUSIONS

Twenty-six 1,500 ft. long pavement sections have been surveyed twice since the first CIR pavements were constructed in Iowa in 1986. The survey results were analyzed in three ways: average of the PCI and PSI values, the PCI values only, and the individual distress type. From these analyses, it can be concluded that the CIR pavements in Iowa have performed very well. Their performance analysis results are summarized below:

1. Due to the subjectivity associated with the PSI data collection method, only PCI values should be considered in performance modeling.
2. CIR roads performed better than expected for the prior service life estimate of 18 years, and therefore have a new estimated service life of 25 years. CIR roads are expected to be in fair condition (PCI value ranging from 55 to 40) between 21 and 25 years, respectively.
3. The predicted service life of the test sections with good subgrade support is much longer than that of the test sections with poor subgrade support. The PCI values of the CIR roads with good subgrade support indicate a fair condition (PCI value ranging from 55 to 40) between 26 and 34 years, respectively. The average service life of CIR roads with good subgrade support is predicted to be 34 years, whereas the service life of CIR roads with poor subgrade support is 22 years.
4. The service life of the test sections under low traffic volumes is very similar to that of the test sections with high traffic volumes. Traffic levels (all less than 2,000 AADT) did not seem to affect performance as much as subgrade support. Particularly, the performance of pavements with good subgrade support was not affected by the traffic level.
5. Longitudinal and alligator cracking increased over time, whereas transverse cracking did not change much.
6. Rutting, patching, and edge cracking increased over time only in those sections with poor subgrade support, whereas block cracking decreased over time in some sections.
7. One section with a very high traffic level (AADT 6,200) has performed reasonably well, although rutting started to develop after three years.

It is recommended that these pavement sections be evaluated again, not only to determine their service lives more accurately, but also to determine the repeatability of the AICS/MIAS method.

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Shahin, M.Y. 2007. *Micro PAVER User Manual*, *Version 5.3*. Fort Collins, CO: Construction Engineering Research Laboratory, U.S. Army Corps of Engineers.

Lee, H. and J. Kim. 2005. *Development of Manual Crack Quantification and Automated Crack Measurement System*. Final Report. TR-457. Iowa City, Iowa: Public Policy Center, University of Iowa.

APPENDIX. CIR MONITORING DATA

The following road segments were observed during the CIR asphalt monitoring study:

A.1. 198th Street, Boone County

Location of Test Section

As shown in Figure A.1.1, the test section located on 198th street, Boone County was constructed in 1988. The beginning and end points of the test section are shown in Figure A.1.2 and A.1.3, respectively.

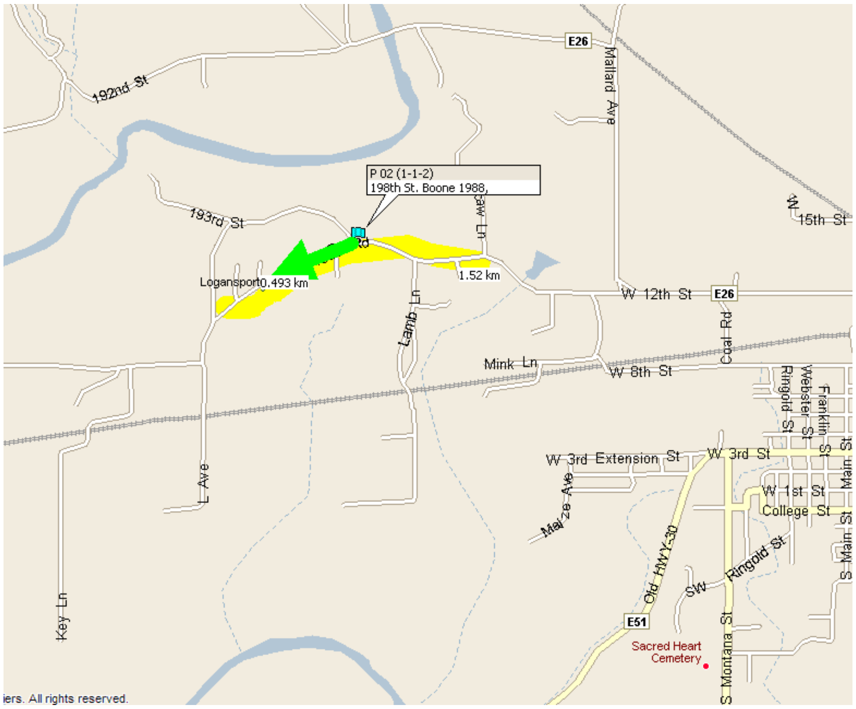

Figure A.1.1. Location of 198th Street test section, Boone County

Figure A.1.2. Beginning point of 198th Street test section, Boone County

Figure A.1.3. End point of 198th Street test section, Boone County

As-built Information

In 1988, as shown in Table A.1.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.1.1. Construction information of 198th Street test section, Boone County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
na	na	6	6	4	67	CSS-1	2	AC-10

Past Evaluation

In 1996, at 8 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.1.2. A traffic volume on the test section was measured at 300 vehicles per day. As shown in Table A.1.2, the test section exhibited a PSI value of 59, a PCI value of 71, resulting in an average value of 65.

Table A.1.2. Previous performance data of 198th Street test section, Boone County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Boone	198th	300	59	71	65

Current Evaluation

As shown in Table A.1.3, the test section exhibited a poor drainage condition and a traffic volume was reduced to 130 vehicles per day from 300 where 5% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.1.3. Current environment information of 198th Street test section, Boone County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
16	Poor	130 (Low traffic)	5%	No

On June 23, 2004, at 16 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.1.4. As shown in Table A.1.4, the most dominant type of distress was alligator cracking with an average area of 240 ft^2 per 100 ft. station. A rutting area is computed as 140 ft^2 per 100 ft. station. The test section exhibited a PSI value of 59, a PCI value of 54 resulting in an average value of 57. Figure A.1.4 shows a sample digital image of sealed longitudinal cracks acquired using the AICS.

Table A.1.4. Current performance data of 198th Street test section, Boone County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
140	21	24	240	0	4	0	59	54	57

(Unit: ft. or ft^2/100 ft.)

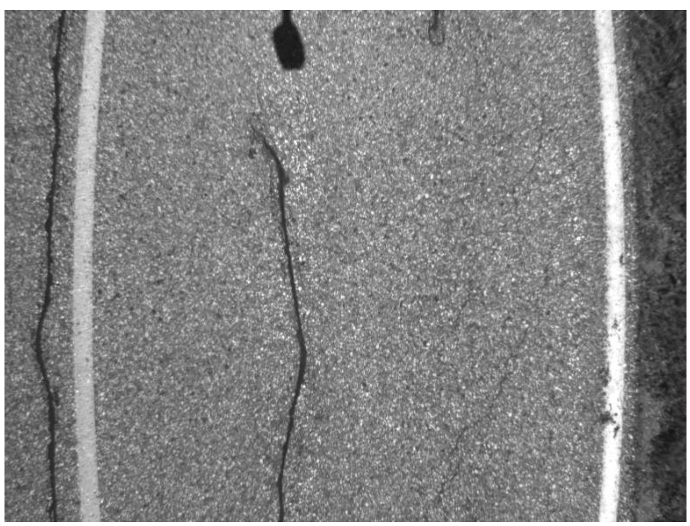

Figure A.1.4 Longitudinal Cracks in 198th Street test section, Boone County

A.2. E 52, Boone County

Location of Test Section

As shown in Figure A.2.1, the test section located on E 52, Boone County was constructed in 1991. The beginning and end points of the test section are shown in Figure A.2.2 and A.2.3, respectively.

Figure A.2.1. Location of E 52 test section, Boone County

Figure A.2.2. Beginning point of E 52 test section, Boone County

Figure A.2.3. End point of E 52 test section, Boone County

As-built Information

In 1991, as shown in Table A.2.1, the existing pavement structure consisted of 8 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.2.1. Construction information of E 52 test section, Boone County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
25-Jun	28-Jun	8	6	4	50	CSS-1	2	AC-10

Past Evaluation

In 1996, at 5 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.2.2. A traffic volume on the test section was measured at 290 vehicles per day. As shown in Table A.2.2, the test section exhibited a PSI value of 73, a PCI value of 95, resulting in an average value of 84.

Table A.2.2. Performance information of E 52 test section, Boone County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Boone	E-52	290	73	95	84

Current Evaluation

As shown in Table A.2.3, the test section exhibited poor support and drainage conditions and a traffic volume was 310-390 vehicles per day where 5-10% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.2.3. Current environment information of E 52 test section, Boone County

Age	Support/Drainage condition	AADT	Truck	New changes since 1996
13	Poor	310~390 (Low traffic)	5~10%	No

On August 11, 2004, at 13 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.2.4. As shown in Table A.2.4, the most dominant type of distress was longitudinal cracking with an average length of 42 ft. per 100 ft. station. A transverse cracking length is computed as 25 ft. per 100 ft. station. The test section exhibited a PSI value of 68, a PCI value of 85 resulting in an average value of 77. Figure 1.2.4 shows a sample digital image of sealed longitudinal crack acquired using the AICS.

Table A.2.4. Current performance data of E 52 test section, Boone County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	42	25	0	0	31	0	68	85	77

(Unit: ft. or ft^2/100 ft.)

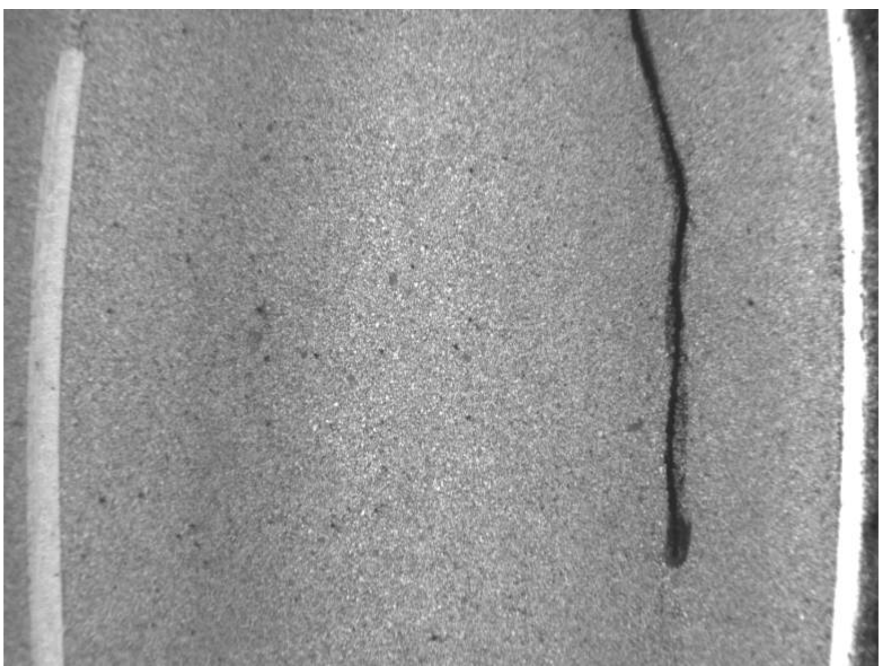

Figure A.2.4. Longitudinal crack of E 52 test section, Boone County

A.3. T 16, Butler County

Location of Test Section

As shown in Figure 1.3.1, the test section located on T 16, Butler County was constructed in 1993. The beginning and end points of the test section are shown in Figure 1.3.2 and 1.3.3, respectively.

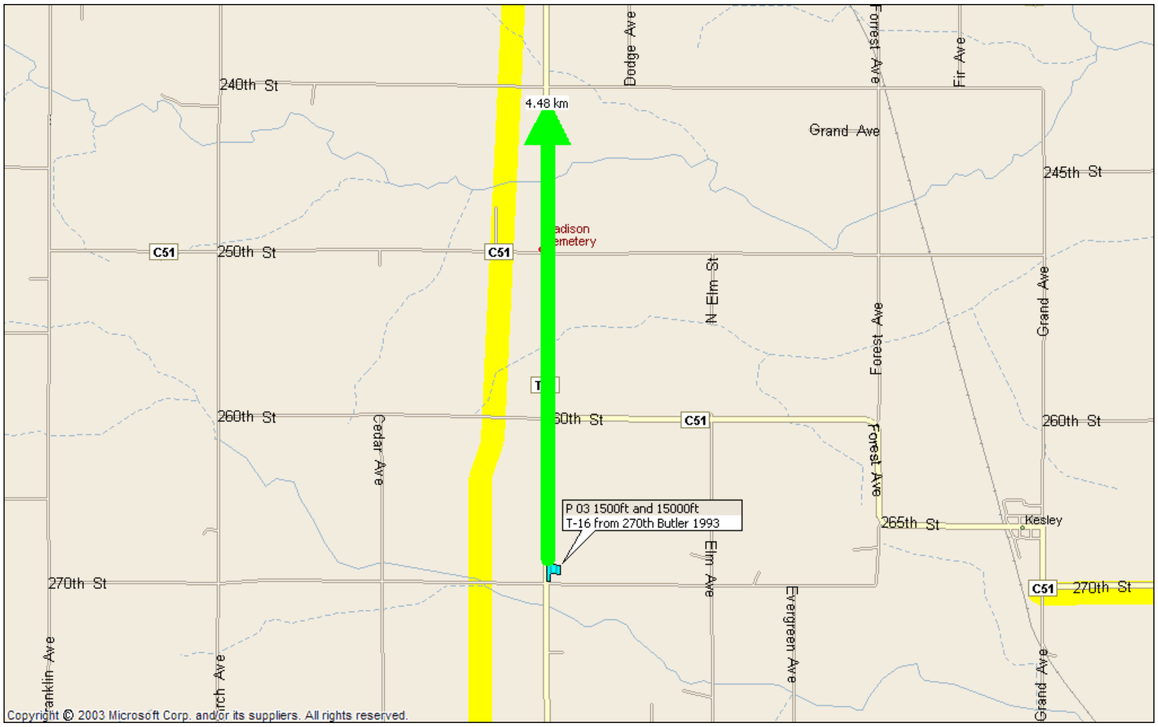

Figure A.3.1. Location of T 16 test section, Butler County

Figure A.3.2. Beginning point of T 16 test section, Butler County

Figure A.3.3. End point of T 16 test section, Butler County

As-built Information

In 1993, as shown in Table A.3.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.3.1. Construction information of T 16 test section, Butler County

Start Date	Finish Date	Asphalt Existing (in.)	Base (in.)	CIR (in.)	CIR Milled %	Emulsion	Overlay (in.)	Asphalt
26-Jul	10-Aug	6	6	4	67	CSS-1	2	AC-5

Past Evaluation

In 1996, at 3 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.3.2. A traffic volume on the test section was measured at 470 vehicles per day. As shown in Table A.3.2, the test section exhibited a PSI value of 81, a PCI value of 100, resulting in an average value of 91.

Table A.3.2. Performance information of T 16 test section, Butler County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Butler	T-16	470	81	100	91

Current Evaluation

As shown in Table A.3.3, the test section was classified into poor support and drainage conditions and low traffic volume with a little higher truck traffic since 1996. There were no major rehabilitations performed on the test section.

Table A.3.3. Current environment information of T 16 test section, Butler County

Age	Support/Drainage condition	AADT	Truck	New changes since 1996
11	Poor	Low traffic	Get a little higher percentage of truck traffic than the normal county road since it goes between Highway 3 and Highway 57	No

On August 9, 2004, at 11 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.3.4. As shown in Table A.3.4, the most dominant type of distress was edge cracking with an average length of 32 ft. per 100 ft. station. A transverse cracking length was computed as 11 ft. per 100 ft. station. The test section exhibited a PSI value of 85, a PCI value of 96 resulting in an average value of 91. Figure 1.3.4 shows a sample digital image of sealed transverse cracks acquired using the AICS.

Table A.3.4 Current performance data of T 16 test section, Butler County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	1	11	0	0	32	0	85	96	91

(Unit: ft. or ft^2/100 ft.)

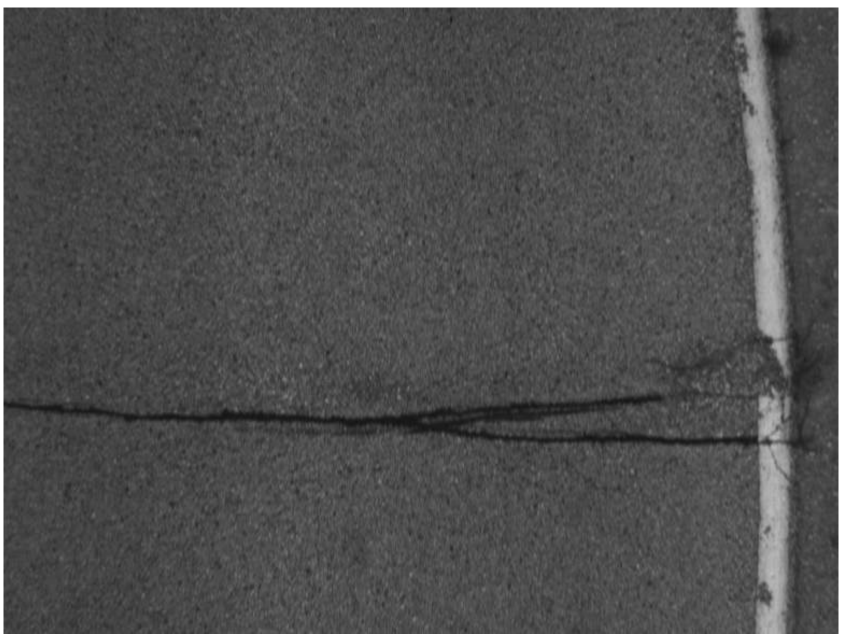

Figure A.3.4 Transverse crack in T 16 test section, Butler County

A.4. IA 175, Calhoun County

Location of Test Section

As shown in Figure 1.4.1, the test section located on IA 175, Calhoun County was constructed in 1994. The beginning and end points of the test section are shown in Figure 1.4.2 and 1.4.3, respectively.

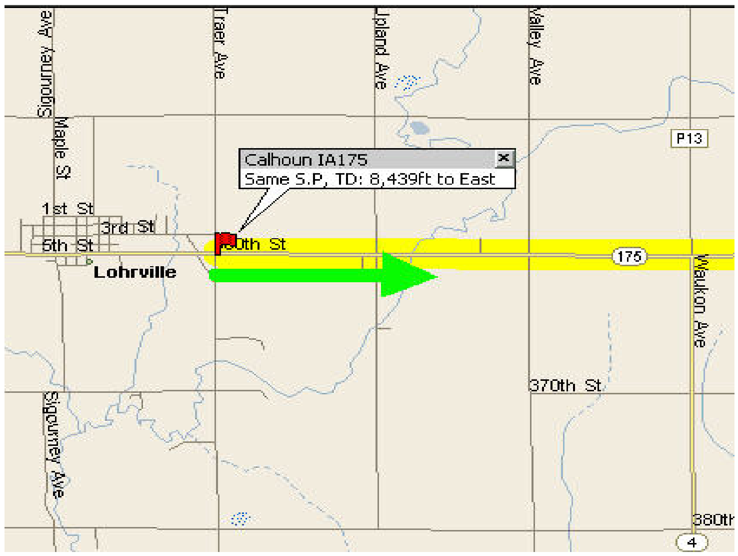

Figure A.4.1. Location of IA 175 test section, Calhoun County

Figure A.4.2. Beginning point of IA 175 test section, Calhoun County

Figure A.4.3. End point of IA 175 test section, Calhoun County

As-built Information

In 1994, as shown in Table A.4.1, the existing pavement structure consisted of 8 in. asphalt surface layer and 8 in. base layer. A top 3 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 4.5 in. asphalt layer.

Table A.4.1. Construction information of IA 175 test section, Calhoun County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
na	na	8	8	3	38	CSS-1	4.5	na

Past Evaluation

In 1997, at 3 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.4.2. A traffic volume on the test section was measured at 1920 vehicles per day. As shown in Table A.4.2, the test section exhibited a PSI value of 81, a PCI value of 100, resulting in an average value of 91.

Table A.4.2. Performance information of IA 175 test section, Calhoun County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Calhoun	IA-175	1920	81	100	91

Current Evaluation

As shown in Table A.4.3, the test section was classified into good support and drainage conditions and a traffic volume was considered higher than 800 vehicles per day. No information was collected in terms of truck traffic volume and rehabilitations performed on the test section since 1996.

Table A.4.3. Current environment information of IA 175 test section, Calhoun County

Age	Support/Drainage condition	AADT	Truck	New changes since 1996
11	Good	>800 (High traffic)	na	na

On February 13, 2005, at 11 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.4.4. As shown in Table A.4.4, the most dominant type of distress was alligator cracking with an average area of 191 ft^2 per 100 ft. station. A rutting area is computed as 55 ft^2 per 100 ft. station. The test section exhibited a PSI value of 56, a PCI value of 63 resulting in an average value of 60. Figure A.4.4 shows a sample digital image of longitudinal and transverse cracks acquired using the AICS.

Table A.4.4. Current performance data of IA 175 test section, Calhoun County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
55	47	22	191	6	4	0	56	63	60

(Unit: ft. or ft^2/100 ft.)

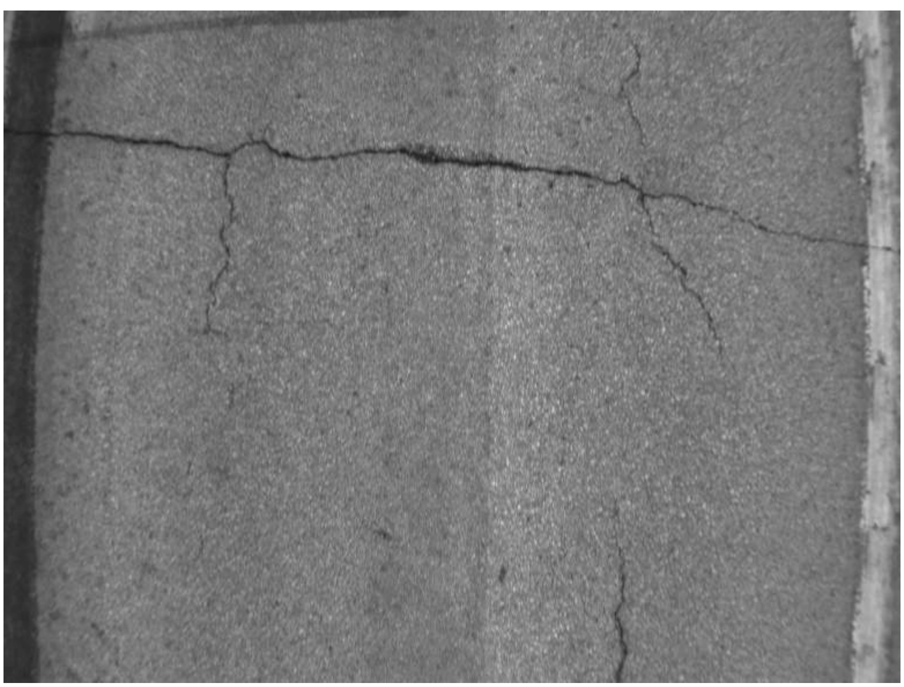

Figure A.4.4. Longitudinal and transverse cracks in IA 175 test section, Calhoun County

A.5. B 43, Cerro Gordo County

Location of Test Section

As shown in Figure A.5.1, the test section located on B 43, Cerro Gordo County was constructed in 1989. The beginning and end points of the test section are shown in Figure A.5.2 and 3.5.3, respectively.

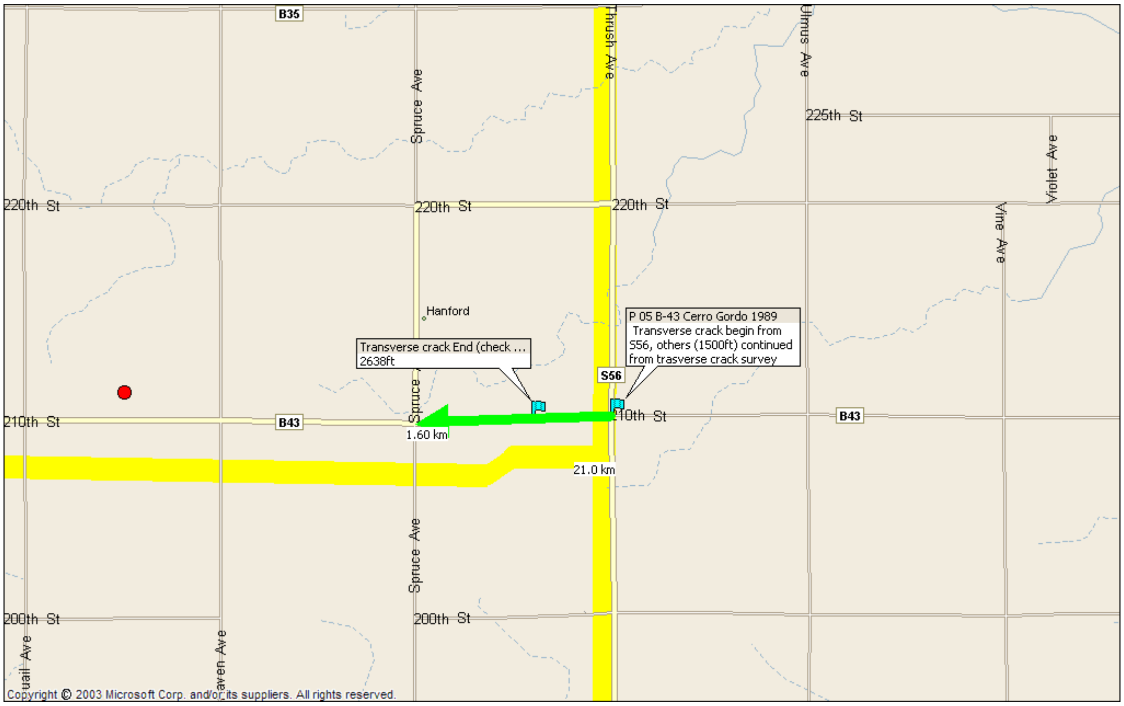

Figure A.5.1. Location of B 43 test section, Cerro Gordo County

Figure A.5.2. Beginning point of B 43 test section, Cerro Gordo County

Figure A.5.3. End point of B 43 test section, Cerro Gordo County

As-built Information

In 1989, as shown in Table A.5.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.5.1. Construction information of B 43 test section, Cerro Gordo County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
30-Jul	7-Aug	6	6	4	67	CSS-1	2	AC-10

Past Evaluation

In 1996, at 7 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.5.2. A traffic volume on the test section was measured at 570 vehicles per day. As shown in Table A.5.2, the test section exhibited a PSI value of 68, a PCI value of 77, resulting in an average value of 72.

Table A.5.2. Performance information of B 43 test section, Cerro Gordo County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Cerro Gordo	B-43	570	68	77	72

Current Evaluation

As shown in Table A.5.3, the test section exhibited fairly good support and drainage conditions and a traffic volume was 300-700 vehicles per day where 10% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.5.3. Current environment information of B 43 test section, Cerro Gordo County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
15	Good	300~700 (Low traffic)	10%, no unusual amount of truck traffic	No

On August 9, 2004, at 15 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.5.4. As shown in Table A.5.4, the most dominant type of distress was transverse cracking with an average length of 167 ft. per 100 ft. station. A longitudinal cracking length is computed as 162 ft. per 100 ft. station. The test section exhibited a PSI value of 45, a PCI value of 61 resulting in an average value of 53. Figure A.5.4 shows a sample digital image of transverse crack acquired using the AICS.

Table A.5.4. Current performance data of B 43 test section, Cerro Gordo County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
5	162	167	0	14	0	0	45	61	53

(Unit: ft. or ft^2/100 ft.)

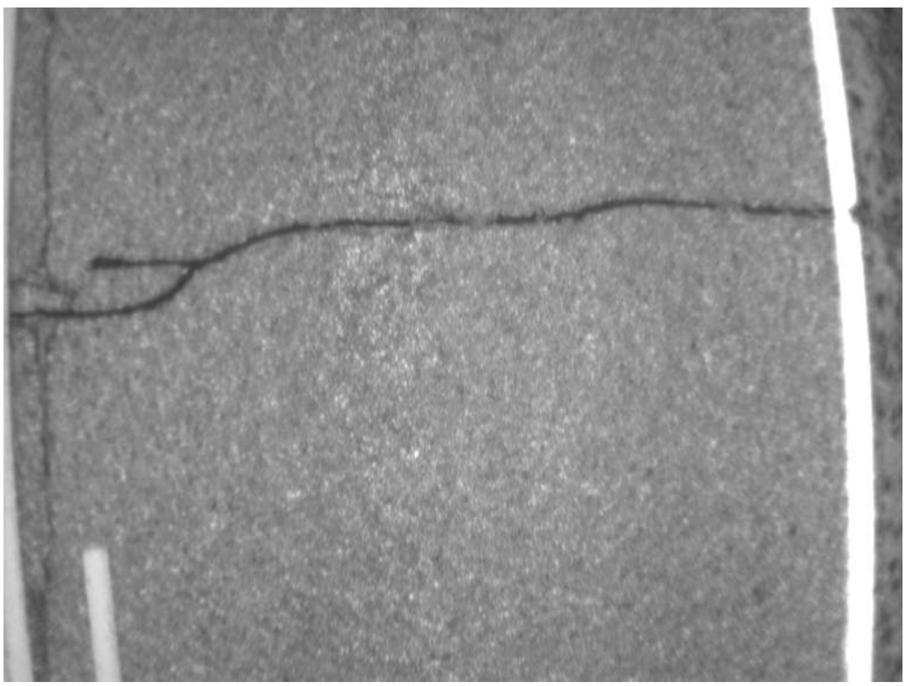

Figure A.5.4. Transverse Crack in B 43 test section, Cerro Gordo County

A.6. South Shore Line, Cerro Gordo County

Location of Test Section

As shown in Figure A.6.1, the test section located on South Shore Line, Cerro Gordo County was constructed in 1990. The beginning point of the test section is shown in Figure A.6.2.

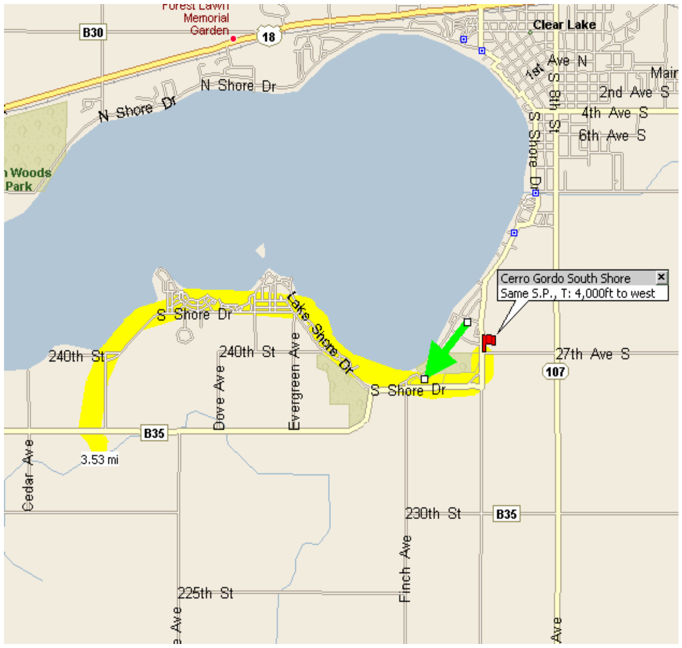

Figure A.6.1. Location of South Shore Line test section, Cerro Gordo County

Figure A.6.2. Beginning point of South Shore Line test section, Cerro Gordo County

As-built Information

In 1990, as shown in Table A.6.1, the existing pavement structure consisted of 8 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.6.1. Construction information of South Shore Line test section, Cerro Gordo County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
8-Aug	17-Aug	8	6	4	50	CSS-1	2	AC-10

Past Evaluation

In 1996, at 6 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.6.2. A traffic volume on the test section was measured at 600 vehicles per day. As shown in Table A.6.2, the test section exhibited a PSI value of 61, a PCI value of 81, resulting in an average value of 71.

Table A.6.2. Performance information of South Shore Line test section, Cerro Gordo County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Cerro Gordo	S.S.L.	600	61	81	71

Current Evaluation

As shown in Table A.6.3, the test section exhibited a good drainage condition and a traffic volume was 1,140 – 4,200 vehicles per day where less than 9% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.6.3. Current environment information of South Shore Line test section, Cerro Gordo County

Age	Support/Drainage condition	AADT	Truck	New changes since 1996
15	Good	1,140~4,200 (High traffic)	< 9%	No

On January 16, 2005, at 15 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.6.4. As shown in Table A.6.4, the most dominant type of distress was alligator cracking with an average area of 149 ft^2 per 100 ft. station. A transverse cracking length is computed as 49 ft. per 100 ft. station. The test section exhibited a PSI value of 66, a PCI value of 54 resulting in an average value of 60. Figure A.6.3 shows a sample digital image of transverse crack acquired using the AICS.

Table A.6.4. Current performance data of South Shore Line test section, Cerro Gordo County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	31	49	149	0	0	2	66	54	60

(Unit: ft. or ft^2/100 ft.)

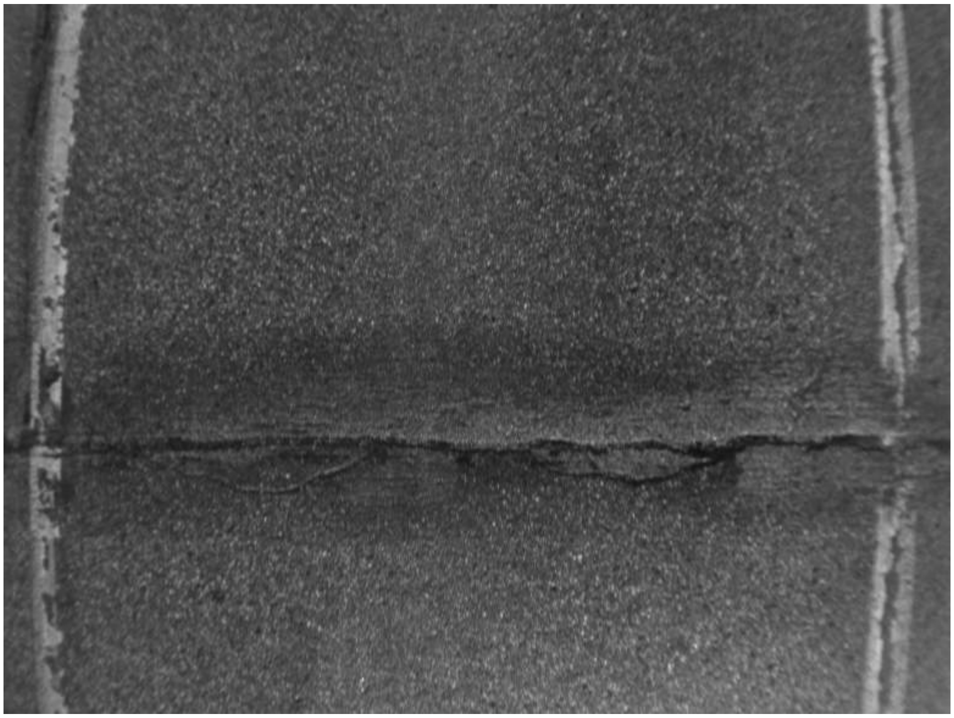

Figure A.6.3 Transverse crack in South Shore Line test section, Cerro Gordo County

A.7. E 50, Clinton County

Location of Test Section

As shown in Figure A.7.1, the test section located on E 50, Clinton County was constructed in 1986. The beginning and end points of the test section are shown in Figure A.7.2 and 3.7.3, respectively.

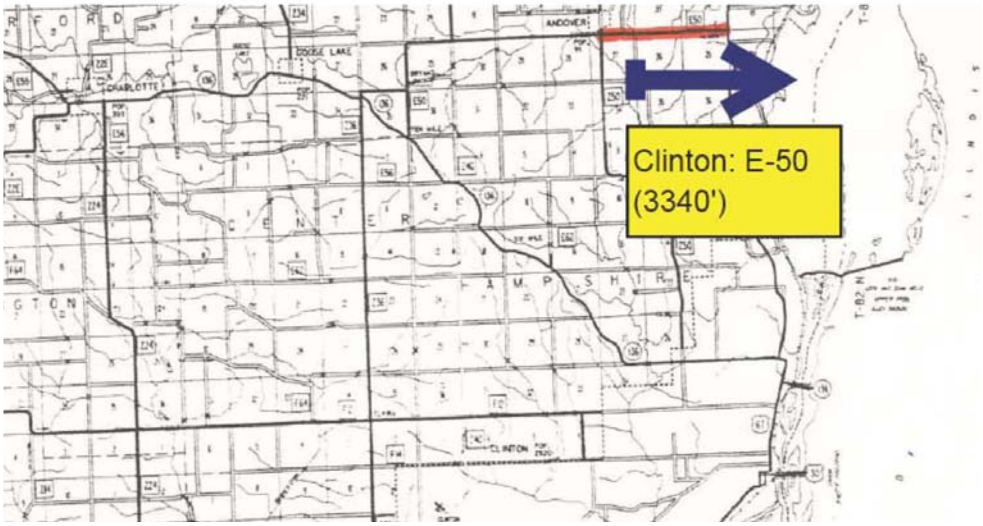

Figure A.7.1. Location of E 50 test section, Clinton County

Figure A.7.2. Beginning point of E 50 test section, Clinton County

Figure A.7.3. End point of E 50 test section, Clinton County

As-built Information

In 1986, as shown in Table A.7.1, the existing pavement structure consisted of 5.5 in. asphalt surface layer and 6.5 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.7.1. Construction information of E 50 test section, Clinton County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
na	20-Aug	5.5	6.5	4	73	CSS-1	2	AC-10

Past Evaluation

In 1996, at 10 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.7.2. A traffic volume on the test section was measured at 520 vehicles per day. As shown in Table A.7.2, the test section exhibited a PSI value of 51, a PCI value of 81, resulting in an average value of 66.

Table A.7.2. Performance information of E 50 test section, Clinton County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Clinton	E-50	520	51	81	66

Current Evaluation

As shown in Table A.7.3, the test section exhibited a good drainage condition, yet was classified into poor support and drainage group and traffic volume was 540 vehicles per day where slightly higher than 9% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.7.3. Current environment information of E 50 test section, Clinton County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
18	Poor	540 in 2002 (Low traffic)	Slightly higher than 9%	No

On August 19, 2004, at 18 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.7.4. As shown in Table A.7.4, the most dominant type of distress was longitudinal cracking with an average length of 172 ft. per 100 ft. station. An alligator cracking area is computed as 136 ft^2 per 100 ft. station. The test section exhibited a PSI value of 51, a PCI value of 48 resulting in an average value of 50. Figure A.7.4 shows a sample digital image of sealed longitudinal cracks acquired using the AICS.

Table A.7.4 Current performance data of E 50 test section, Clinton County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
60	172	64	136	0	42	84	51	48	50

(Unit: ft. or ft^2/100 ft.)

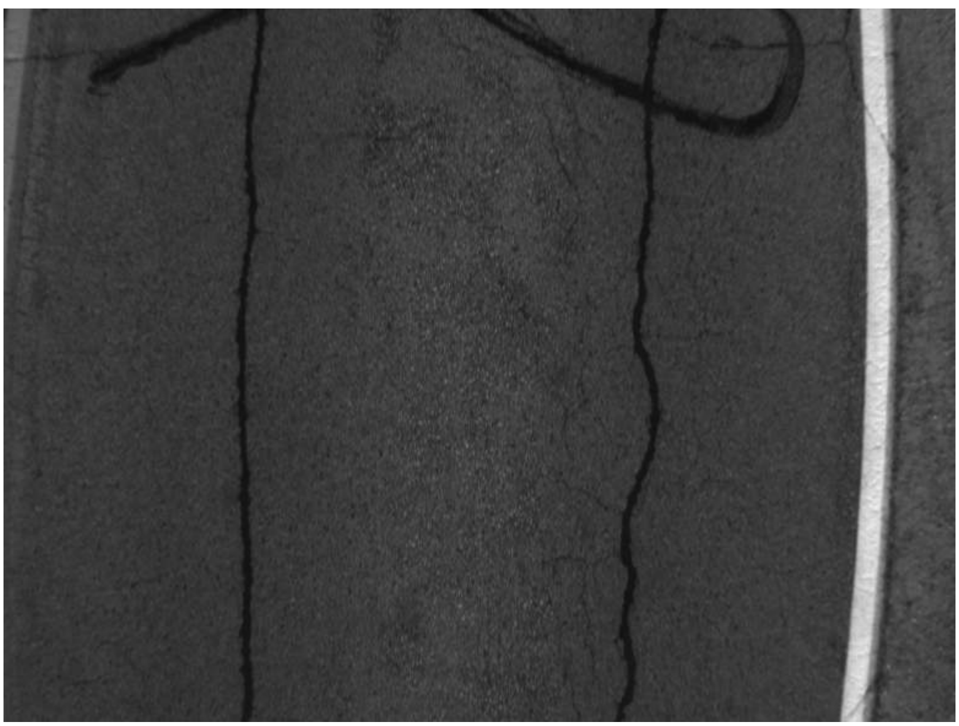

Figure A.7.4. Longitudinal cracks in E 50 test section, Clinton County

A.8. Z 30, Clinton County

Location of Test Section

As shown in Figure A.8.1, the test section located on Z 30, Clinton County was constructed in 1989. The beginning and end points of the test section are shown in Figure A.8.2 and 3.8.3, respectively.

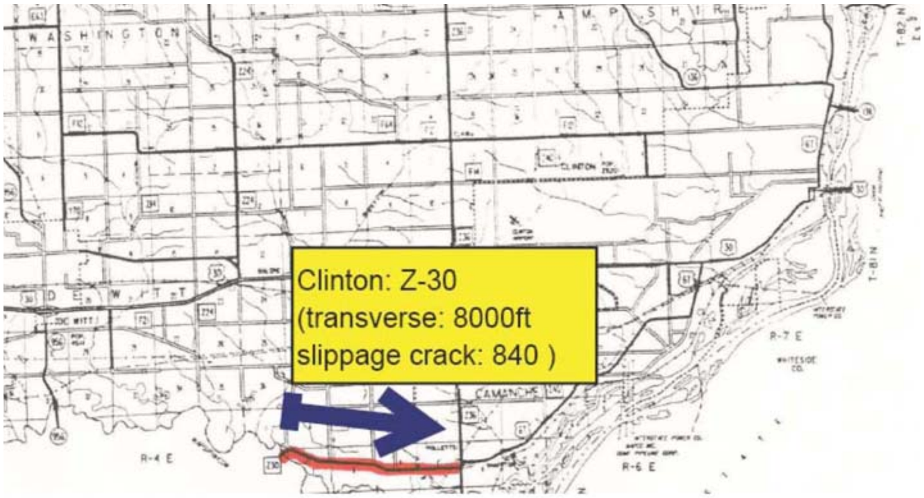

Figure A.8.1. Location of Z 30 test section, Clinton County

Figure A.8.2. Beginning point of Z 30 test section, Clinton County

Figure A.8.3. Ending point of Z 30 test section, Clinton County

As-built Information

In 1989, as shown in Table A.8.1, the existing pavement structure consisted of 5 in. asphalt surface layer and 10 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.8.1. Construction information of Z 30 test section, Clinton County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
13-Jun	19-Jun	5	10	4	80	CSS-1	2	AC-10

Past Evaluation

In 1996, at 7 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.8.2. A traffic volume on the test section was measured at 850 vehicles per day. As shown in Table A.8.2, the test section exhibited a PSI value of 64, a PCI value of 93, resulting in an average value of 78.

Table A.8.2. Performance information of Z 30 test section, Clinton County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Clinton	Z-30	850	64	93	78

Current Evaluation

As shown in Table A.8.3, the test section exhibited a fair drainage condition and a traffic volume slightly increased to 910 vehicles per day from 850 where 9% was truck traffic. There were no major rehabilitations performed on the test section.

Table A.8.3. Current environment information of Z 30 test section, Clinton County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
15	Good	910 in 2002 (High traffic)	9%	No

On August 19, 2004, at 15 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.8.4. As shown in Table A.8.4, the most dominant type of distress was longitudinal cracking with an average length of 452 ft. per 100 ft. station. A transverse cracking length is computed as 61 ft. per 100 ft. station. The test section exhibited a PSI value of 51, a PCI value of 70 resulting in an average value of 61. Figure A.8.4 shows a sample digital image of sealed longitudinal cracks acquired using the AICS.

Table A.8.4 Current performance data of Z 30 test section, Clinton County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	452	61	30	43	0	0	51	70	61

(Unit: ft. or ft^2/100 ft.)

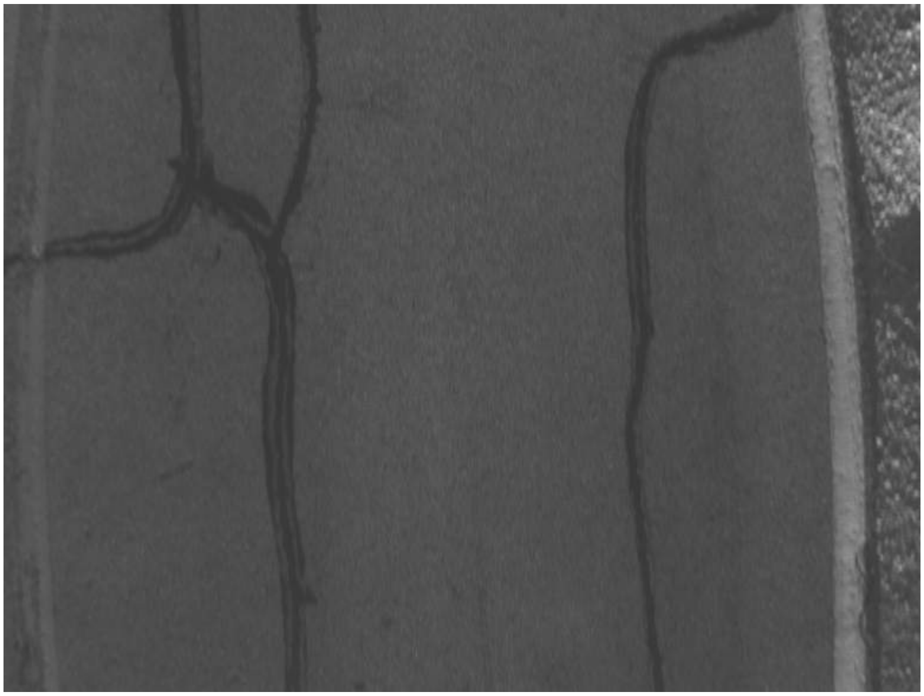

Figure A.8.4 Longitudinal Cracks in Z 30 test section, Clinton County

A.9. IA 144, Greene County

Location of Test Section

As shown in Figure A.9.1, the test section located on IA 144, Greene County was constructed in 1990. The beginning point of the test section is shown in Figure A.9.2.

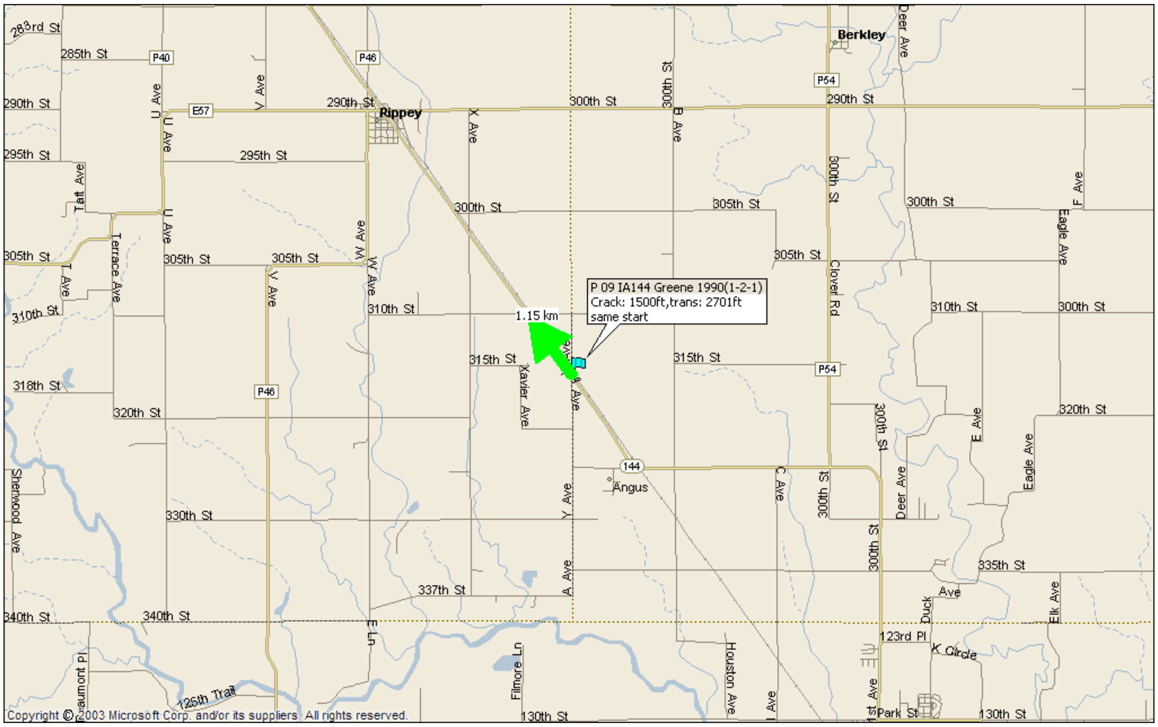

Figure A.9.1. Location of IA 144 test section, Greene County

Figure A.9.2. Beginning point of IA 144 test section, Greene County

As-built Information

In 1990, as shown in Table A.9.1, the existing pavement structure consisted of 4–6 in. of asphalt surface layer and 6 in. of base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 and CMS-2P emulsions. It was overlaid with 2 in. asphalt layer.

Table A.9.1. Construction information of IA 144 test section, Greene County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
5-May	15 June	4 to 6	6	4	67 to 100	CSS-1, CMS-2P	2	AC-10

Past Evaluation

In 1996, at 6 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.9.2. A traffic volume on the test section was measured at 1110 vehicles per day. As shown in Table A.9.2, the test section exhibited a PSI value of 58, a PCI value of 60, resulting in an average value of 59.

Table A.9.2. Performance information of IA 144 test section, Greene County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Greene	IA-144	1110	58	60	59

Current Evaluation

As shown in Table A.9.3, the test section exhibited a poor drainage condition and a traffic volume slightly increased to 1770 vehicles per day from 1110. There were no major rehabilitations performed on the test section.

Table A.9.3. Current environment information of IA 144 test section, Greene County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
14	Poor	1770 (High traffic)	na	No

On August 11, 2004, at 14 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.9.4. As shown in Table A.9.4, the most dominant type of distress was alligator cracking with an average area of 385 ft^2 per 100 ft. station. A transverse cracking length is computed as 109 ft. per 100 ft. station. The test section exhibited a PSI value of 50, a PCI value of 54 resulting in an average value of 52. Figure A.9.3 shows a sample digital image of alligator crack acquired using the AICS.

Table A.9.4. Current performance data of IA 144 test section, Greene County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
65	61	109	385	13	36	0	50	54	52

(Unit: ft. or ft^2/100 ft.)

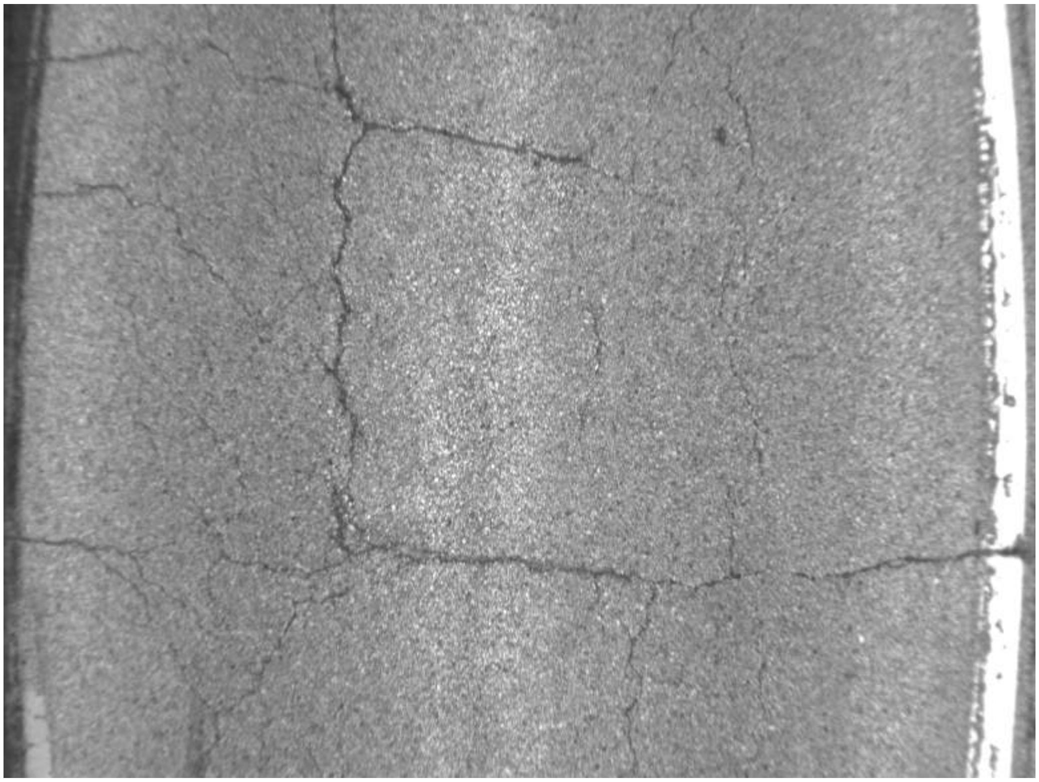

Figure A.9.3 Alligator crack in IA 144 test section, Greene County

A.10. IA 4, Guthrie County

Location of Test Section

As shown in Figure A.10.1, the test section located on IA 4, Guthrie County was constructed in 1995. The beginning and end points of the test section are shown in Figure A.10.2 and 3.10.3, respectively.

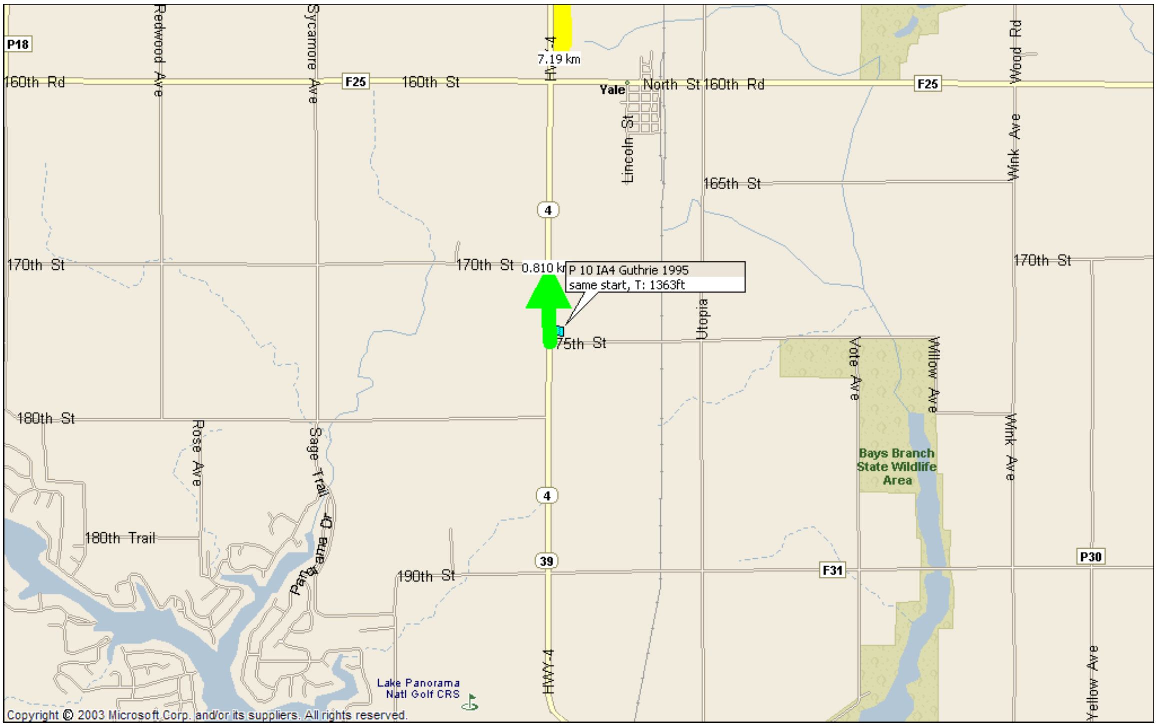

Figure A.10.1. Location of IA 4 test section, Guthrie County

Figure A.10.2. Beginning point of IA 4 test section, Guthrie County

Figure A.10.3. End point of IA 4 test section, Guthrie County

As-built Information

In 1995, as shown in Table A.10.1, the existing pavement structure consisted of 6–8 in. asphalt surface layer and base layer of which thickness was unknown. A top 4 in. asphalt layer was milled and recycled using CSS-1H emulsion. It was overlaid with 3 in. asphalt layer.

Table A.10.1. Construction information of IA 4 test section, Guthrie County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
19 June	7 July	6 to 8	na	4	50 to 67%	CSS-1H	3	AC-10

Past Evaluation

In 1997, at 2 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.10.2. A traffic volume on the test section was measured at 820 vehicles per day. As shown in Table A.10.2, the test section exhibited a PSI value of 90, a PCI value of 100, resulting in an average value of 95.

Table A.10.2. Performance information of IA 4 test section, Guthrie County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Guthrie	IA-4	820	90	100	95

Current Evaluation

As shown in Table A.10.3, the test section was classified into good support and drainage conditions group and traffic volume increased to 1850 vehicles per day. No information was collected in terms of truck traffic volume and rehabilitations performed on the test section since 1996.

Table A.10.3. Current environment information of IA 4 test section, Guthrie County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
9	Good	1850 (High traffic)	NA	NA

On August 11, 2004, at 9 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.10.4. As shown in Table A.10.4, there was only transverse cracking with an average length of 25 ft. per 100 ft. station. The test section exhibited a PSI value of 78, a PCI value of 98 resulting in an average value of 88. Figure A.10.4 shows a sample digital image of transverse crack acquired using the AICS.

Table A.10.4 Current performance data of IA 4 test section, Guthrie County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	25	0	0	0	0	78	98	88

(Unit: ft. or ft^2/100 ft.)

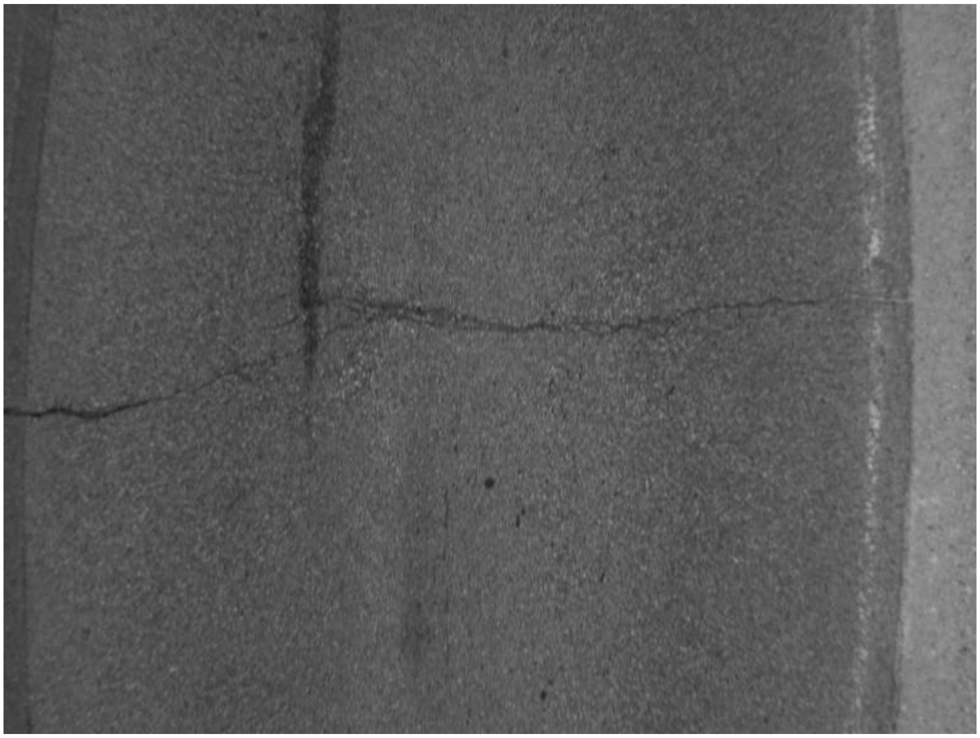

Figure A.10.4. Transverse crack in IA 4 test section, Guthrie County

A.11. D 35, Hardin County

Location of Test Section

As shown in Figure A.11.1, the test section located on D 35, Hardin County was constructed in 1992. The beginning point of the test section is shown in Figure A.11.2.

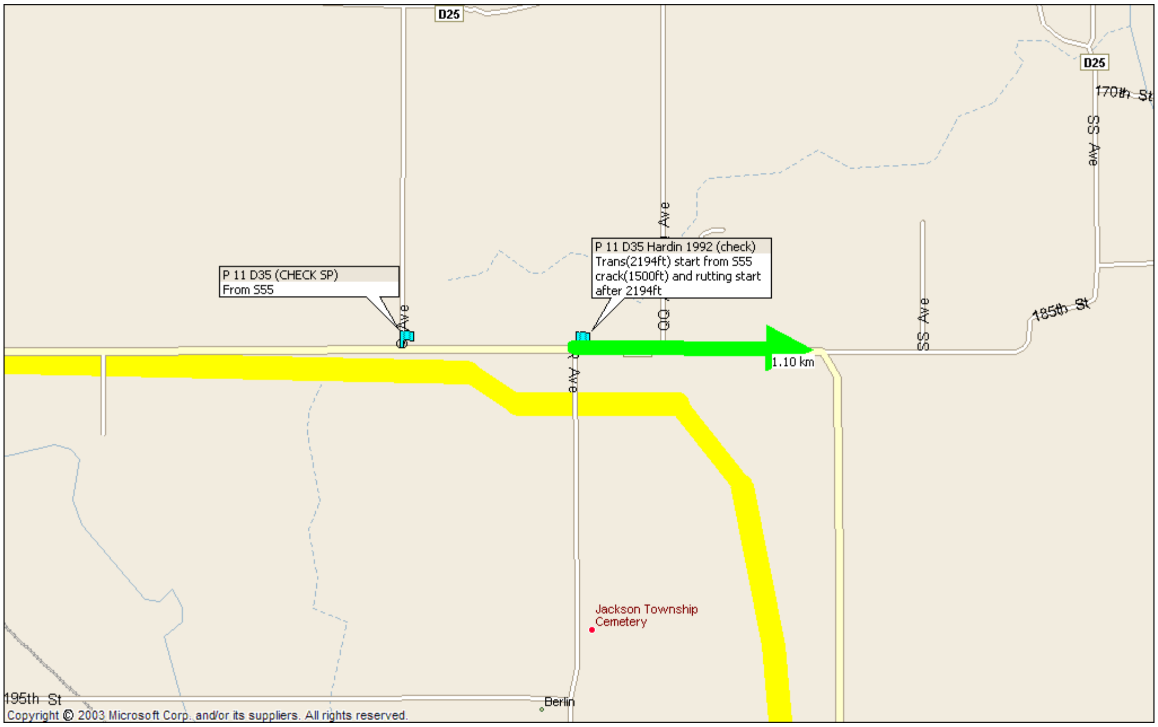

Figure A.11.1. Location of D 35 test section, Hardin County

Figure A.11.2. Beginning point of D 35 test section, Hardin County

As-built Information

In 1992, as shown in Table A.11.1, the existing pavement structure consisted of 6.5 in. asphalt surface layer and 6 in. base layer. A top 3 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.11.1. Construction information of D 35 test section, Hardin County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
9-Jul	20-Jul	6.5	6	3	46	CSS-1	2	AC-10

Past Evaluation

In 1996, at 4 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.11.2. A traffic volume on the test section was measured at 665 vehicles per day. As shown in Table A.11.2, the test section exhibited a PSI value of 65, a PCI value of 85, resulting in an average value of 75.

Table A.11.2. Performance information of D 35 test section, Hardin County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Hardin	D-35	665	65	85	75

Current Evaluation

As shown in Table A.11.3, the test section exhibited a fair drainage condition. A traffic volume increased to 1,500 vehicles per day from 665 while the test section was served as a shortcut for the traffic of highway 20. Since the opening of highway 520 August 2003, the traffic volume has dropped to 600 vehicles per day. There were no major rehabilitations performed on the test section.

Table A.11.3. Current environment information of D 35 test section, Hardin County

Age	Support/Drainage Condition	Traffic Volume	Truck	New changes since 1996
12	Poor	D-35 has served as a short-cut for Highway 20 traffic, and during the period between completing Highway 20 to Iowa 65 and Highway 14. Therefore, traffic volumes were running in the neighborhood of 1,500 VPD with an abnormally high secondary road percentage of trucks.	was high	No except the change of traffic volume

On August 9, 2004, at 12 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.11.4. As shown in Table A.11.4, the most dominant type of distress was transverse cracking with an average length of 85 ft. per 100 ft. station. A longitudinal cracking length is computed as 37 ft. per 100 ft. station. The test section exhibited a PSI value of 63, a PCI value of 78 resulting in an average value of 71. Figure A.11.3 shows a sample digital image of transverse cracks acquired using the AICS.

Table A.11.4. Current performance data of D 35 test section, Hardin County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
20	37	85	30	0.0	4	0	63	78	71

(Unit: ft. or ft^2/100 ft.)

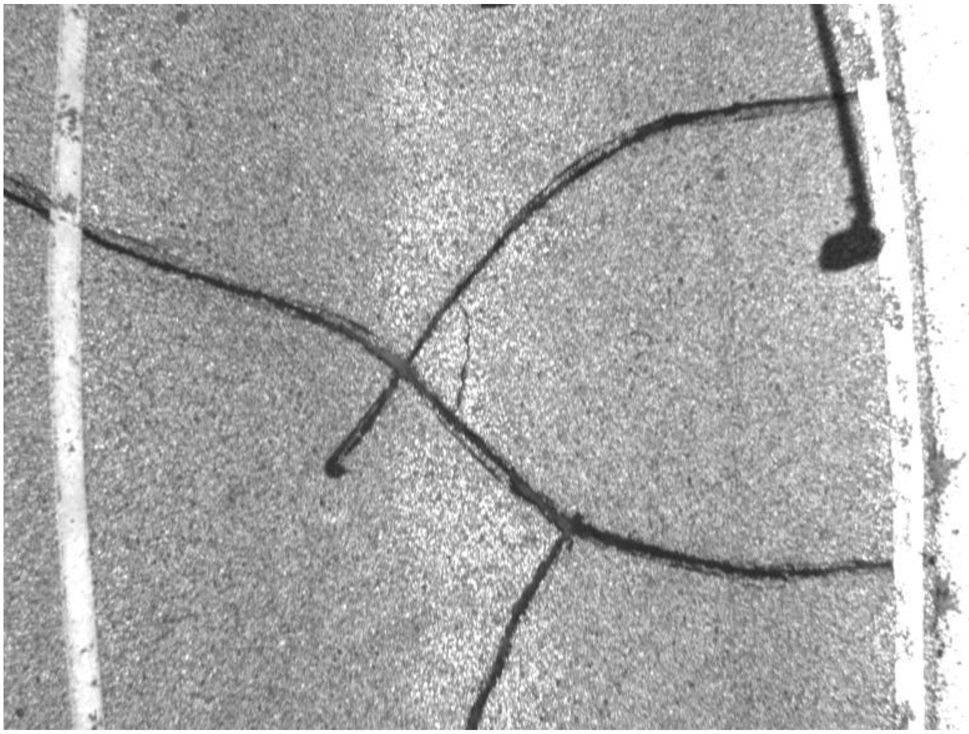

Figure A.11.3. Transverse Cracks in D 35 test section, Hardin County

A.12. F 70, Muscatine County

Location of Test Section

As shown in Figure A.12.1, the test section located on F 70, Muscatine County was constructed in 1993. The beginning and end points of the test section are shown in Figure A.12.2 and 3.12.3, respectively.

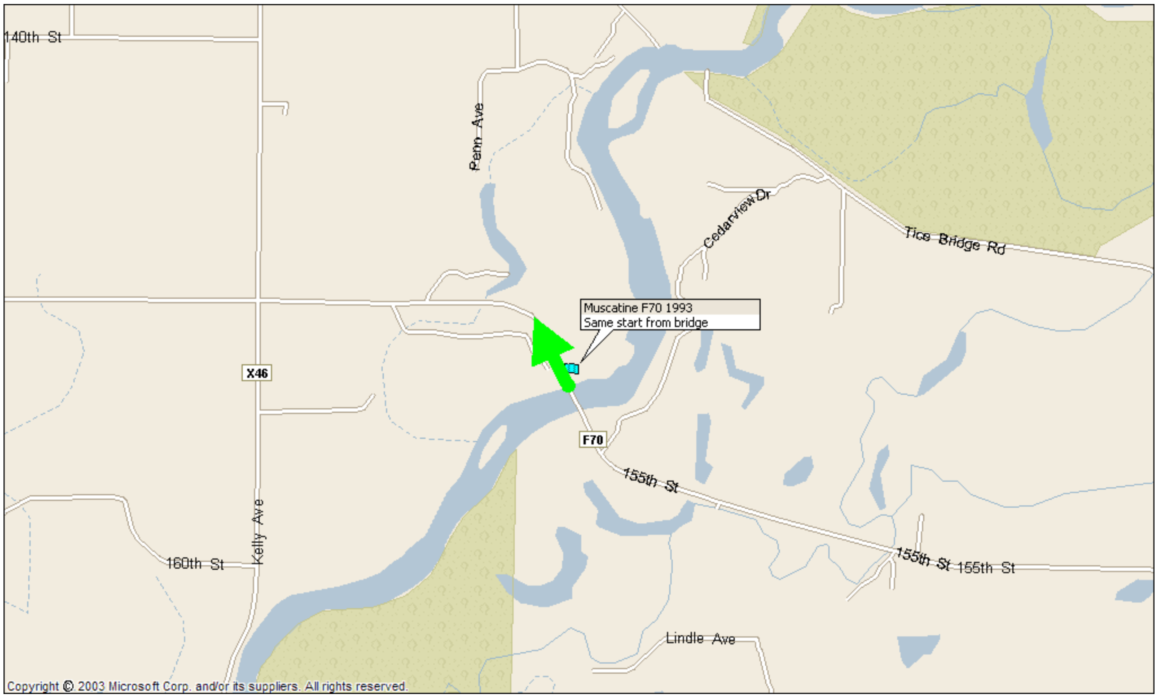

Figure A.12.1. Location of F 70 test section, Muscatine County

Figure A.12.2. Beginning point of F 70 test section, Muscatine County

Figure A.12.3. End point of F 70 test section, Muscatine County

As-built Information

In 1993, as shown in Table A.12.1, the existing pavement structure consisted of 4 in. asphalt surface layer and 8 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 3 in. asphalt layer.

Table A.12.1. Construction information of F 70 test section, Muscatine County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
26-Aug	20-Sep	4	8	4	100	CSS-1	3	AC-5

Past Evaluation

In 1996, at 3 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.12.2. A traffic volume on the test section was measured at 950 vehicles per day. As shown in Table A.12.2, the test section exhibited a PSI value of 82, a PCI value of 100, resulting in an average value of 91.

Table A.12.2. Performance information of F 70 test section, Muscatine County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Muscatine	F-70	950	82	100	91

Current Evaluation

As shown in Table A.12.3, the test section exhibited good support and average drainage conditions and a traffic volume increased from 950 vehicles per day to 1250 in 2002. There were no major rehabilitations performed on the test section.

Table A.12.3. Current environment information of F 70 test section, Muscatine County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
11	Good	1250 in 2002 (High traffic)	N/A	No

On August 19, 2004, at 11 years since construction, another distress survey was conducted using an AICS and a rutting device. The survey results are summarized in Table A.12.4. As shown in Table A.12.4, the most dominant type of distress was longitudinal cracking with an average length of 34 ft. per 100 ft. station. A transverse cracking length is computed as 7 ft. per 100 ft. station. The test section exhibited a PSI value of 75, a PCI value of 92 resulting in an average value of 84. Figure A.12.4 shows a sample digital image of sealed longitudinal crack acquired using the AICS.

Table A.12.4. Current performance data of F 70 test section, Muscatine County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
5	34	7	0	0	4	0	75	92	84

(Unit: ft. or ft^2/100 ft.)

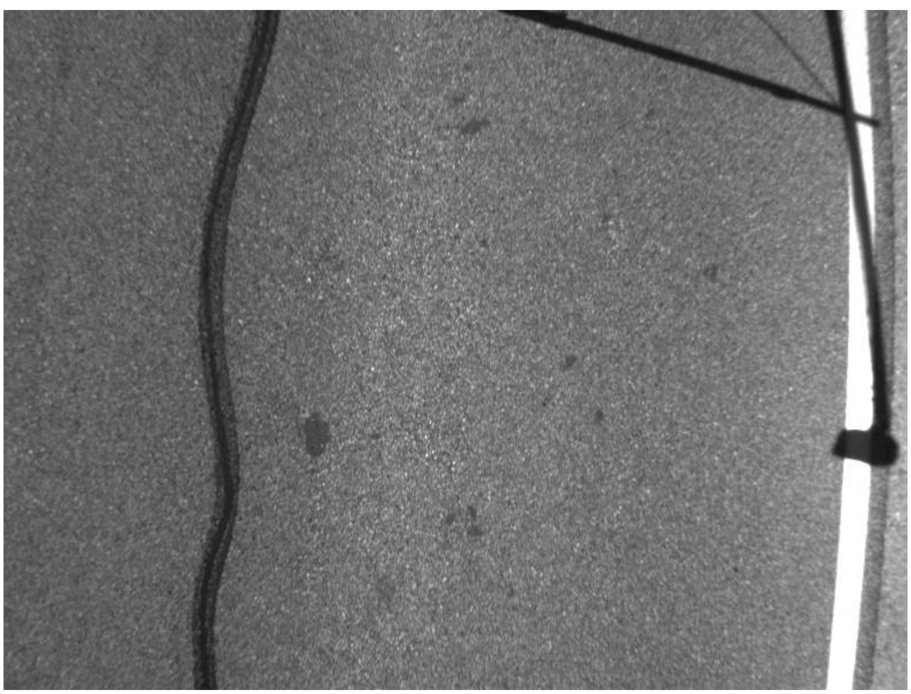

Figure A.12.4. Longitudinal crack in F 70 test section, Muscatine County

A.13. G 28, Muscatine County

Location of Test Section

As shown in Figure A.13.1, the test section located on G 28, Muscatine County was constructed in 1991. The beginning and end points of the test section are shown in Figure A.13.2 and 3.13.3, respectively.

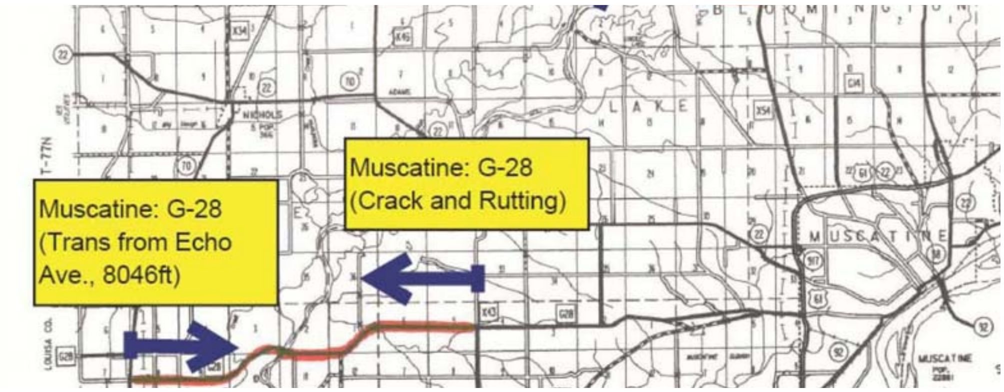

Figure A.13.1. Location of test section on G 28, Muscatine County

Figure A.13.2. Beginning point of G 28 test section, Muscatine County

Figure A.13.3. End point of G 28 test section, Muscatine County

As-built Information

In 1991, as shown in Table A.13.1, the existing pavement structure consisted of 8 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using CSS-1 emulsion. It was overlaid with 2 in. asphalt layer.

Table A.13.1. Construction information of G 28 test section, Muscatine County

Start Date	Finish Date	Asphalt Existing (in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
15-Sep	22-Sep	8	6	4	50	CSS-1	2	AC-5/10

Past Evaluation

In 1996, at 5 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.13.2. A traffic volume on the test section was measured at 940 vehicles per day. As shown in Table A.13.2, the test section exhibited a PSI value of 73, a PCI value of 98, resulting in an average value of 85.

Table A.13.2. Performance information of G 28 test section, Muscatine County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Muscatine	G-28	940	73	98	85

Current Evaluation

As shown in Table A.13.3, the test section exhibited poor support and drainage conditions and a traffic volume slightly increased to 960 - 1100 vehicles per day in 2002. There were no major rehabilitations performed on the test section.

Table A.13.3. Current environment information of G 28 test section, Muscatine County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
13	Poor	960~1100 in 2002	N/A	No

On August 19, 2004, at 13 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.13.4. As shown in Table A.13.4, the most dominant type of distress was longitudinal cracking with an average length of 257 ft. per 100 ft. station. A patching area is computed as 65 ft^2 per 100 ft. station. The test section exhibited a PSI value of 51, a PCI value of 73 resulting in an average value of 62. Figure A.13.4 shows a sample digital image of patching and sealed crack acquired using the AICS.

Table A.13.4. Current performance data of G 28 test section, Muscatine County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
10	257	73	0	9	1	65	51	73	62

(Unit: ft. or ft^2/100 ft.)

Figure A.13.4. Patching and sealed crack in G 28 test section, Muscatine County

A.14. Y 14, Muscatine County

Location of Test Section

As shown in Figure A.14.1, the test section located on Y 14, Muscatine County was constructed in 1987. The beginning and end points of the test section are shown in Figure A.14.2 and 3.14.3, respectively.

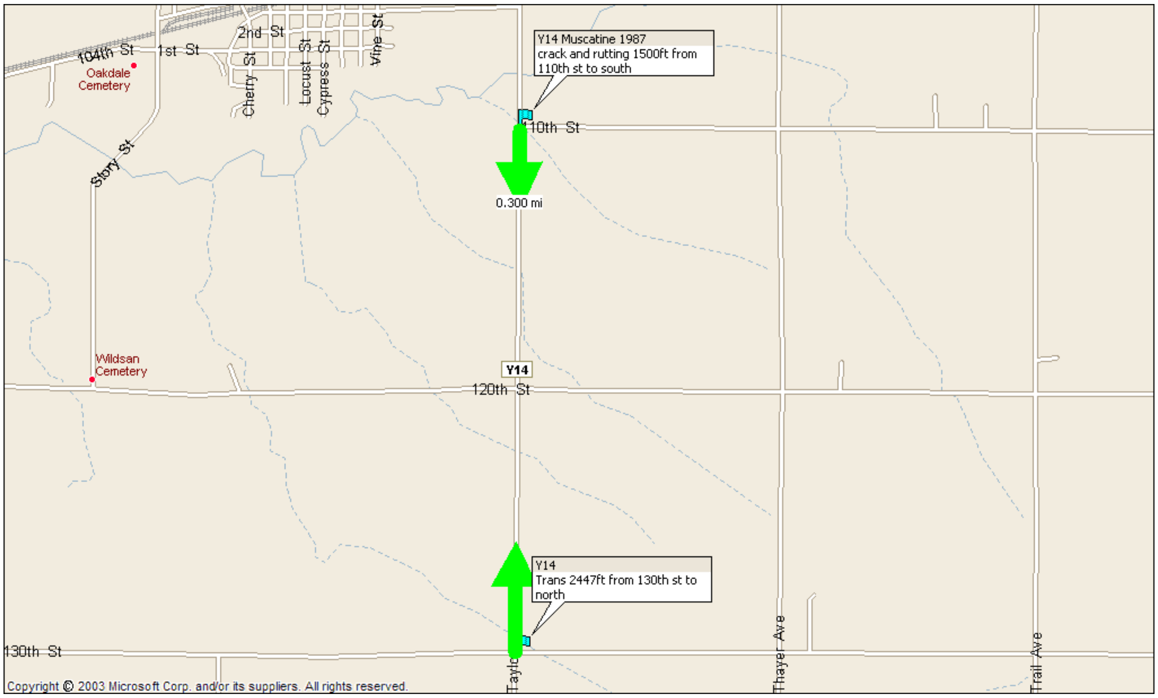

Figure A.14.1 Location of Y 14 test section, Muscatine County

Figure A.14.2. Beginning point of Y 14 test section, Muscatine County

Figure A.14.3. End point of Y 14 test section, Muscatine County

As-built Information

In 1987, as shown in Table A.14.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using HFE-150S, CSS-1 and HFMS emulsions. It was overlaid with 2.5 in. asphalt layer.

Table A.14.1. Construction information of Y 14 test section, Muscatine County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
22-Jun	4-Jul	6	6	4	67	HFE-150S, CSS-1, HFMS	2.5	AC-10

Past Evaluation

In 1996, at 9 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.14.2. A traffic volume on the test section was measured at 990 vehicles per day. As shown in Table A.14.2, the test section exhibited a PSI value of 61 a PCI value of 52, resulting in an average value of 57.

Table A.14.2. Performance information of Y 14 test section, Muscatine County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Muscatine	Y-14	990	61	52	57

Current Evaluation

As shown in Table A.14.3, the test section exhibited poor support and very poor drainage conditions and a traffic volume increased to 1160 - 1490 vehicles per day from 990. There were no major rehabilitations performed on the test section.

Table A.14.3. Current environment information of Y 14 test section, Muscatine County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
17	Poor/very poor	1160~1490 in 2002 (High traffic)	N/A	No

On August 19, 2004, at 17 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.14.4. As shown in Table A.14.4, the most dominant type of distress was block cracking with an average area of 274 ft^2 per 100 ft. station. A transverse cracking area is computed as 248 ft. per 100 ft. station. The test section exhibited a PSI value of 423, a PCI value of 60 resulting in an average value of 52. Figure A.14.4 shows a sample digital image of sealed block crack acquired using the AICS.

Table A.14.4. Current performance data of Y 14 test section, Muscatine County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
45	173	248	24	274	5	153	43	60	52

(Unit: ft. or ft^2/100 ft.)

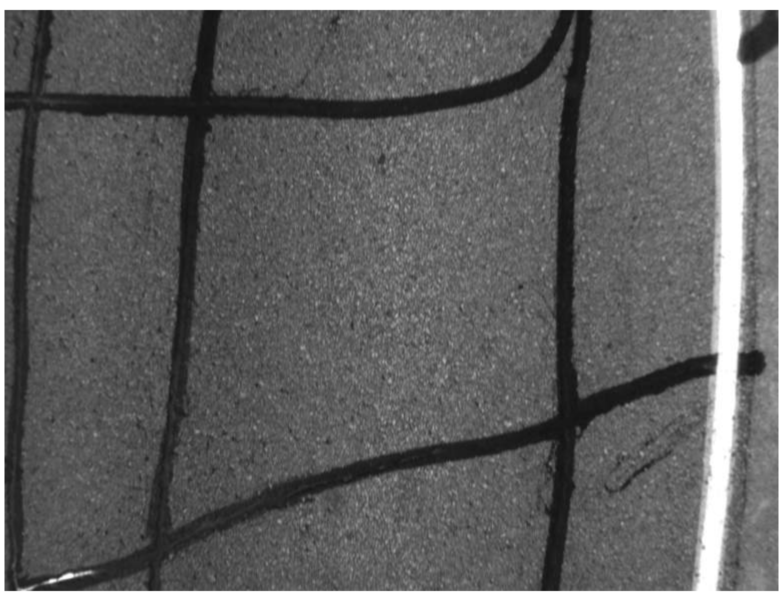

Figure A.14.4. Block Crack in Y 14 test section, Muscatine County

A.15. E 66, Tama County

Location of Test Section

As shown in Figure A.15.1, the test section located on E 66, Tama County was constructed in 1990. The beginning and end points of the test section are shown in Figure A.15.2 and 3.15.3, respectively.

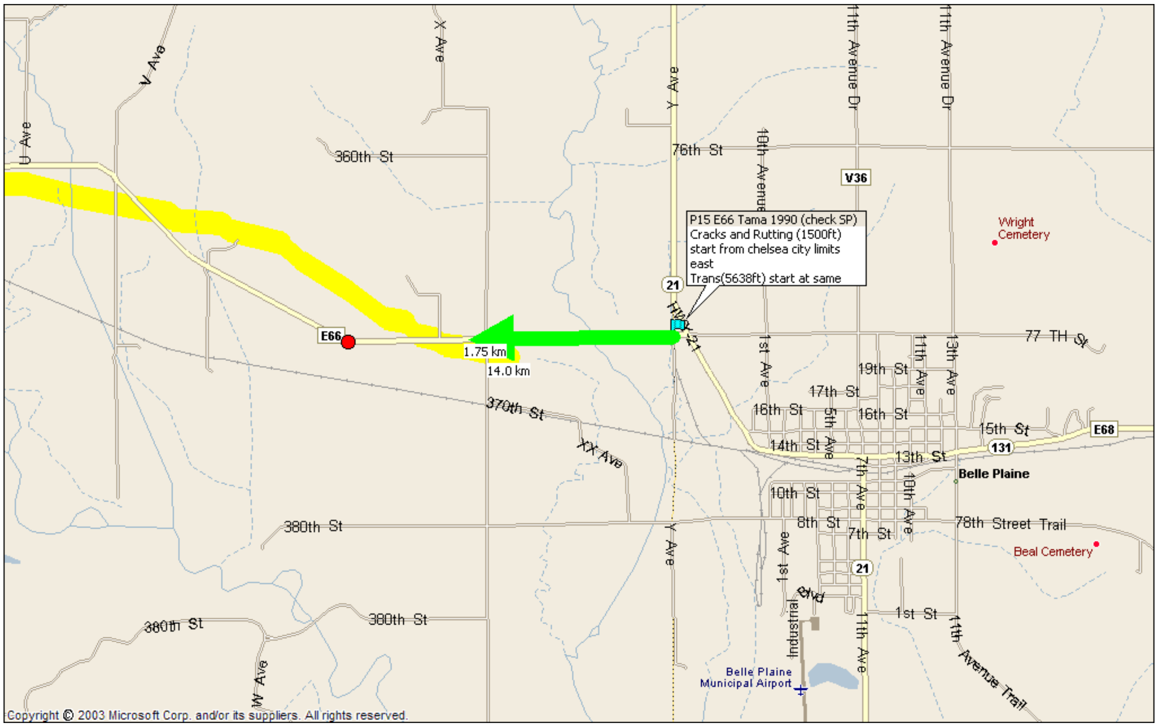

Figure A.15.1. Location of E 66 test section, Tama County

Figure A.15.2. Beginning point of E 66 test section, Tama County

Figure A.15.3. End point of E 66 test section, Tama County

As-built Information

In 1990, as shown in Table A.15.1, the existing pavement structure consisted of 4 in. asphalt surface layer and 8 in. base layer. A top 4 in. asphalt layer was milled and recycled using HF-300RP emulsion. It was overlaid with 2 in. asphalt layer.

Table A.15.1. Construction information of E 66 test section, Tama County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
12-Jul	28-Jul	4	8(pcc)	4	100	HF-300RP	2	AC-5

Past Evaluation

In 1996, at 6 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.15.2. A traffic volume on the test section was measured at 1080 vehicles per day. As shown in Table A.15.2, the test section exhibited a PSI value of 61, a PCI value of 94, resulting in an average value of 78.

Table A.15.2. Performance information of E 66 test section, Tama County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Tama	E-66	1080	61	94	78

Current Evaluation

As shown in Table A.15.3, the test section exhibited a good drainage condition and a traffic volume remained same since 1996. There were no major rehabilitations performed on the test section.

Table A.15.3. Current environment information of E 66 test section, Tama County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
14	Good	1080	Same	No

On August 15, 2004, at 14 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.15.4. As shown in Table A.15.4, the most dominant type of distress was transverse cracking with an average length of 13 ft. per 100 ft. station. A rutting area is computed as 5 ft^2 per 100 ft. station. The test section exhibited a PSI value of 71, a PCI value of 93 resulting in an average value of 82. Figure A.15.4 shows a sample digital image of sealed transverse crack acquired using the AICS.

Table A.15.4. Current performance data of E 66 test section, Tama County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
5	4	13	0	0	0	0	71	93	82

(Unit: ft. or ft^2/100 ft.)

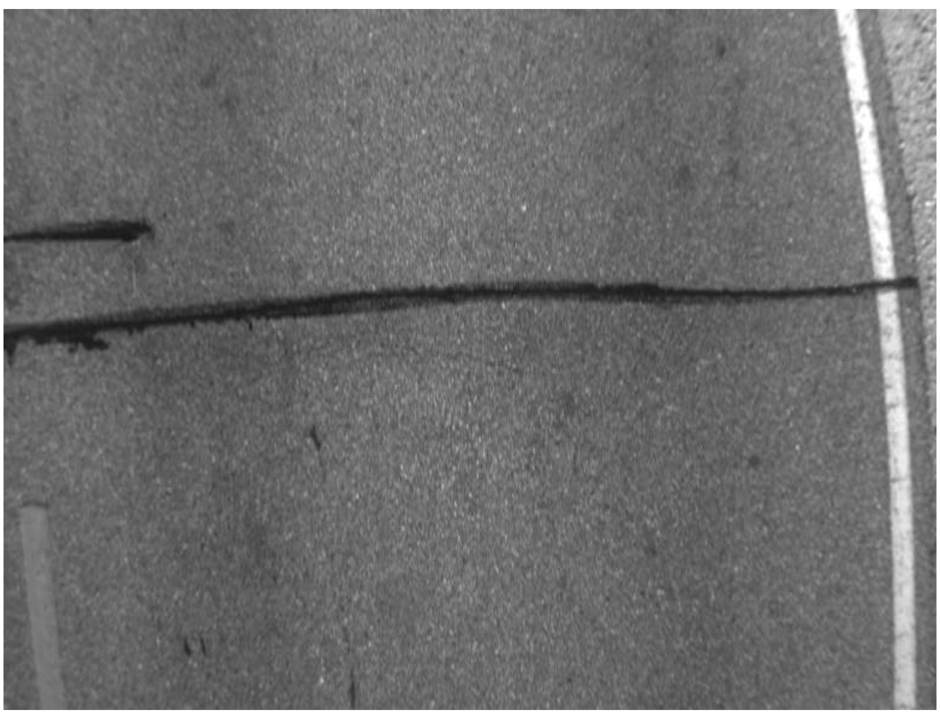

Figure A.15.4. Transverse crack in E 66 test section, Tama County

A.16. V 18, Tama County

Location of Test Section

As shown in Figure A.16.1, the test section located on V 18, Tama County was constructed in 1991. The beginning and end points of the test section are shown in Figure A.16.2 and 3.16.3, respectively.

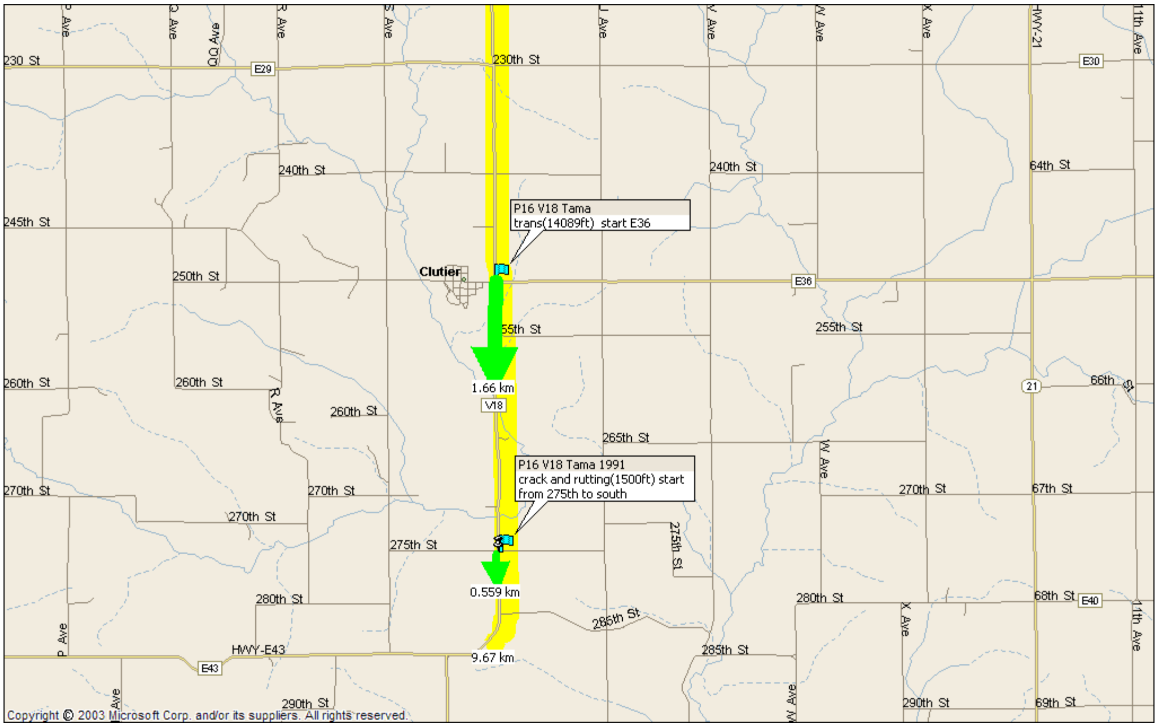

Figure A.16.1. Location of V 18 test section, Tama County

Figure A.16.2. Beginning point of V 18 test section, Tama County

Figure A.16.3. End point of V 18 test section, Tama County

As-built Information

In 1991, as shown in Table A.16.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using HF-300 and CSS-1 emulsions. It was overlaid with 2 in. asphalt layer.

Table A.16.1. Construction information of V 18 test section, Tama County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
24-Sep	11-Jul	6	6	4	67	HF-300RP, CSS-1	2	AC-5

Past Evaluation

In 1996, at 5 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.16.2. A traffic volume on the test section was measured at 550 vehicles per day. As shown in Table A.16.2, the test section exhibited a PSI value of 70, a PCI value of 100, resulting in an average value of 85.

Table A.16.2. Performance information of V 18 test section, Tama County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Tama	V-18	550	70	100	85

Current Evaluation

As shown in Table A.16.3, the test section was classified as poor support and drainage conditions and a traffic volume remained same since 1996. There were no major rehabilitations performed on the test section.

Table A.16.3. Current environment information of V 18 test section, Tama County

Age	Support/Drainage Condition	Traffic Volume	Truck	New changes since 1996
13	Poor	550	Same	No

On August 15, 2004, at 13 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.16.4. As shown in Table A.16.4, the most dominant type of distress was transverse cracking with an average length of 12 ft. per 100 ft. station. An edge cracking length is computed as 4 ft. per 100 ft. station. The test section exhibited a PSI value of 74, a PCI value of 97 resulting in an average value of 86. Figure A.16.4 shows a sample digital image of sealed transverse crack acquired using the AICS.

Table A.16.4. Current performance data of V 18 test section, Tama County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	1	12	0	0	4	0	74	97	86

(Unit: ft. or ft^2/100 ft.)

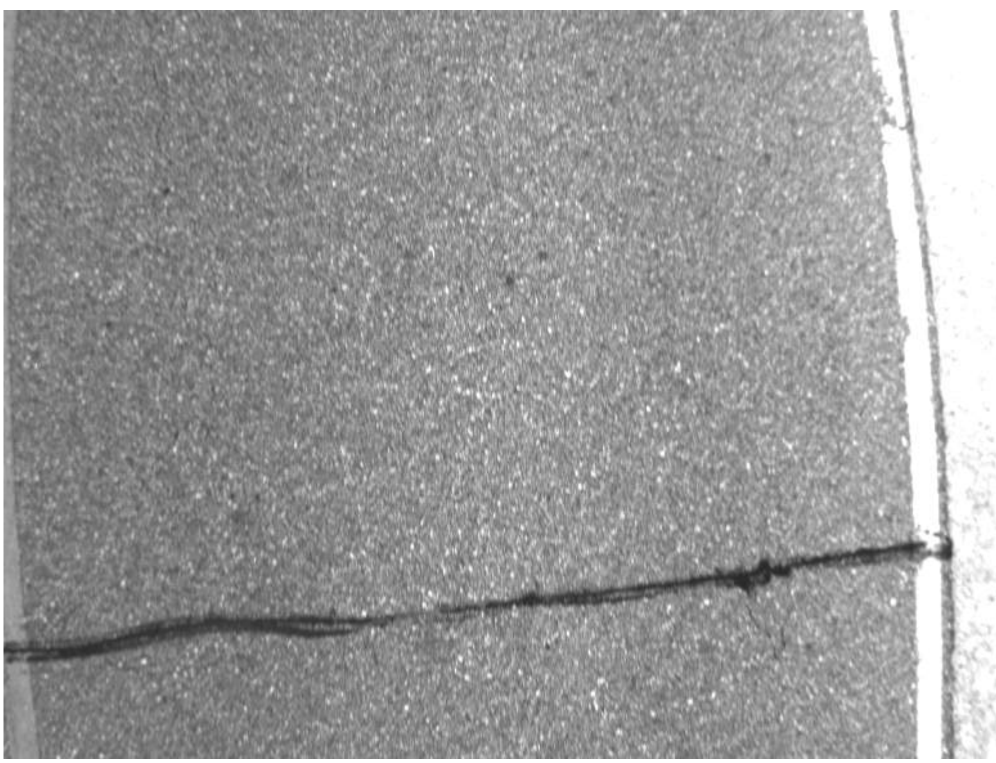

Figure A.16.4. Transverse crack in V 18 test section, Tama County

A.17. R 34, Winnebago County

Location of Test Section

As shown in Figure A.17.1, the test section located on R 34, Winnebago County was constructed in 1990. The beginning and end points of the test section are shown in Figure A.17.2 and 3.17.3, respectively.

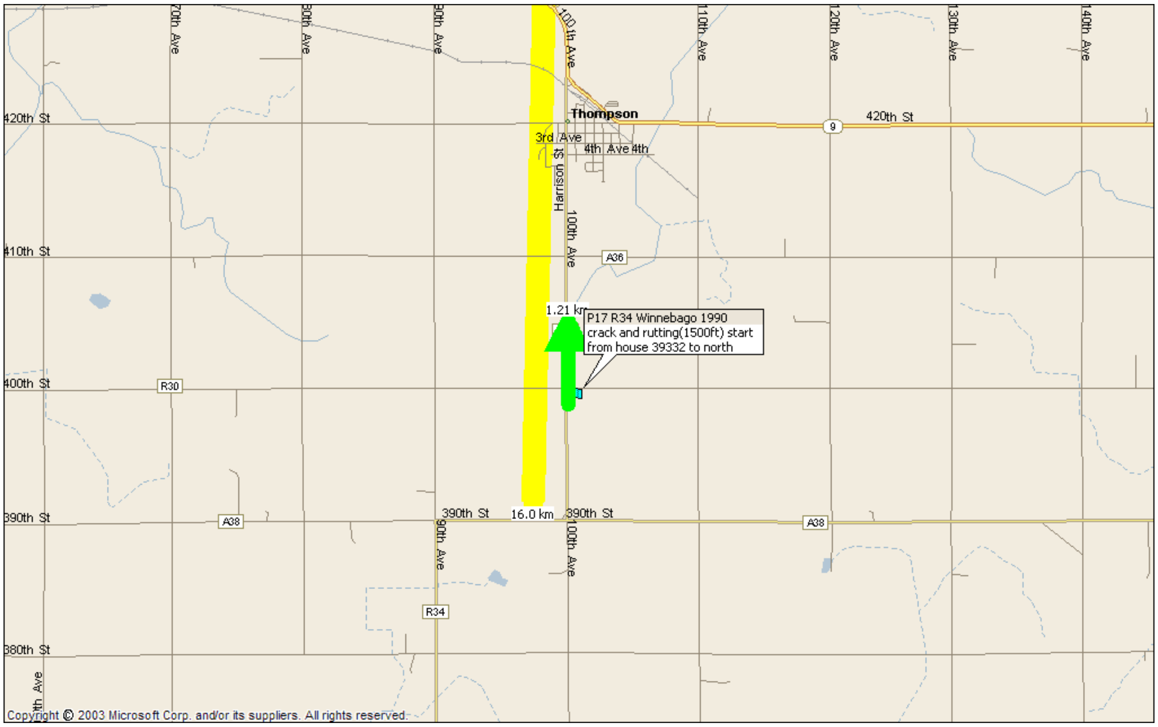

Figure A.17.1. Location of R 34 test section, Winnebago County

Figure A.17.2. Beginning point of R 34 test section, Winnebago County

Figure A.17.3. End point of R 34 test section, Winnebago County

As-built Information

In 1990, as shown in Table A.17.1, the existing pavement structure consisted of 6 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using HF-300RP emulsion. It was overlaid with 2 in. asphalt layer.

Table A.17.1. Construction information of R 34 test section, Winnebago County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
18-Jul	30-Jul	6	6	4	67	HF-300RP	2	AC-5

Past Evaluation

In 1996, at 6 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.17.2. A traffic volume on the test section was measured at 620 vehicles per day. As shown in Table A.17.2, the test section exhibited a PSI value of 63, a PCI value of 90, resulting in an average value of 76.

Table A.17.2. Performance information of R 34 test section, Winnebago County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Winnebago	R-34	620	63	90	76

Current Evaluation

As shown in Table A.17.3, the test section exhibited good support and good drainage conditions and a traffic volume was reduced to 270 - 490 vehicles per day from 620 where 9% was truck traffic. Crack sealing has been performed on the test section since 1996.

Table A.17.3. Current environment information of R 34 test section, Winnebago County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
14	Good	270 ~ 490 (Low traffic)	9%	Crack sealing

On August 10, 2004, at 14 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.17.4. As shown in Table A.17.4, the most dominant type of distress was transverse cracking with an average length of 64 ft. per 100 ft. station. A longitudinal cracking length is computed as 31 ft. per 100 ft. station. The test section exhibited a PSI value of 58, a PCI value of 89 resulting in an average value of 74. Figure A.17.4 shows a sample digital image of transverse crack acquired using the AICS.

Table A.17.4. Current performance data of R 34 test section, Winnebago County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
10	31	64	0	0	0	0	58	89	74

(Unit: ft. or ft^2/100 ft.)

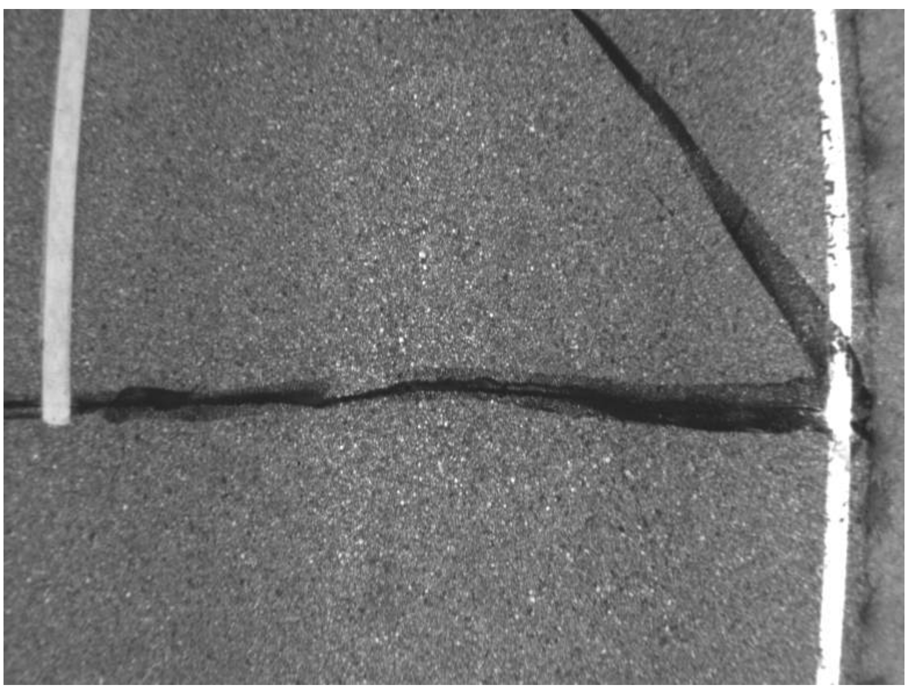

Figure A.17.4. Transverse .rack in R 34 test section, Winnebago County

A.18. R 60, Winnebago County

Location of Test Section

As shown in Figure A.18.1, the test section located on R 60, Winnebago County was constructed in 1990. The beginning and end points of the test section are shown in Figure A.18.2 and 3.18.3, respectively.

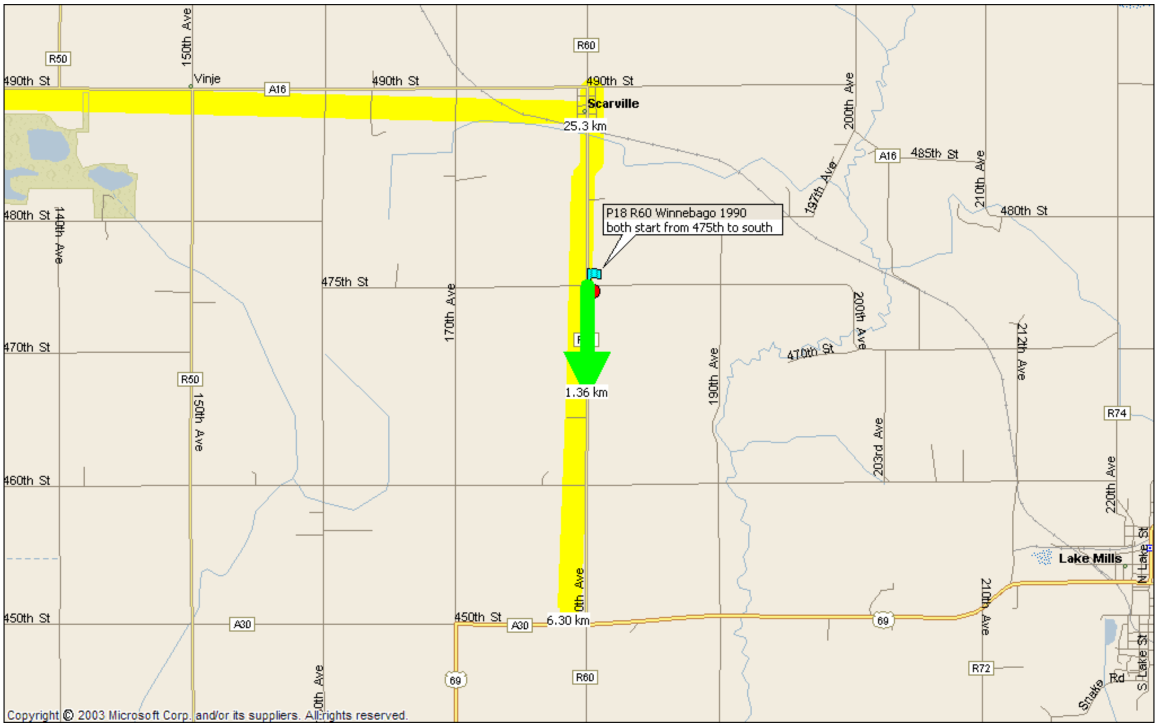

Figure A.18.1. Location of R 60 test section, Winnebago County

Figure A.18.2. Beginning point of R 60 test section, Winnebago County

Figure A.18.3. End point of R 60 test section, Winnebago County

As-built Information

In 1990, as shown in Table A.18.1, the existing pavement structure consisted of 5 in. asphalt surface layer and 6 in. base layer. A top 4 in. asphalt layer was milled and recycled using HF-300RP emulsion. It was overlaid with 2 in. asphalt layer.

Table A.18.1. Construction information of R 60 test section, Winnebago County

Start Date	Finish Date	Asphalt Existing(in)	Base (in)	CIR (in)	CIR Milled %	Emulsion	Overlay (in)	Asphalt
13-Jul	18-Jul	5	6	4	80	HF-300RP	2	AC-5

Past Evaluation

In 1996, at 6 years since construction, a distress survey was conducted on the test section and the survey results are summarized in Table A.18.2. A traffic volume on the test section was measured at 340 vehicles per day. As shown in Table A.18.2, the test section exhibited a PSI value of 63, a PCI value of 72, resulting in an average value of 67.

Table A.18.2. Performance information of R 60 test section, Winnebago County

County	Road	AADT	PSI	PCI	(PSI+PCI)/2
Winnebago	R-60	340	63	72	67

Current Evaluation

As shown in Table A.18.3, the test section exhibited poor support and good drainage conditions and a traffic volume increased to 540 vehicles per day from 340 where 7% was truck traffic. Crack sealing has been performed on the test section since 1996.

Table A.18.3. Current environment information of R 60 test section, Winnebago County

Age	Support/Drainage Condition	AADT	Truck	New changes since 1996
14	Good	540 (Low traffic)	7%	Crack sealing

On August 10, 2004, at 14 years since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.18.4. As shown in Table A.18.4, the most dominant type of distress was block cracking with an average area of 2200 ft^2 per 100 ft. station. A rutting area is computed as 10 ft^2 per 100 ft. station. The test section exhibited a PSI value of 45, a PCI value of 70 resulting in an average value of 58. Figure A.18.4 shows a sample digital image of sealed longitudinal and transverse cracks acquired using the AICS.

Table A.18.4. Current performance data of R 60 test section, Winnebago County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
10	0	0	0	2200	0	0	45	70	58

(Unit: ft. or ft^2/100 ft.)

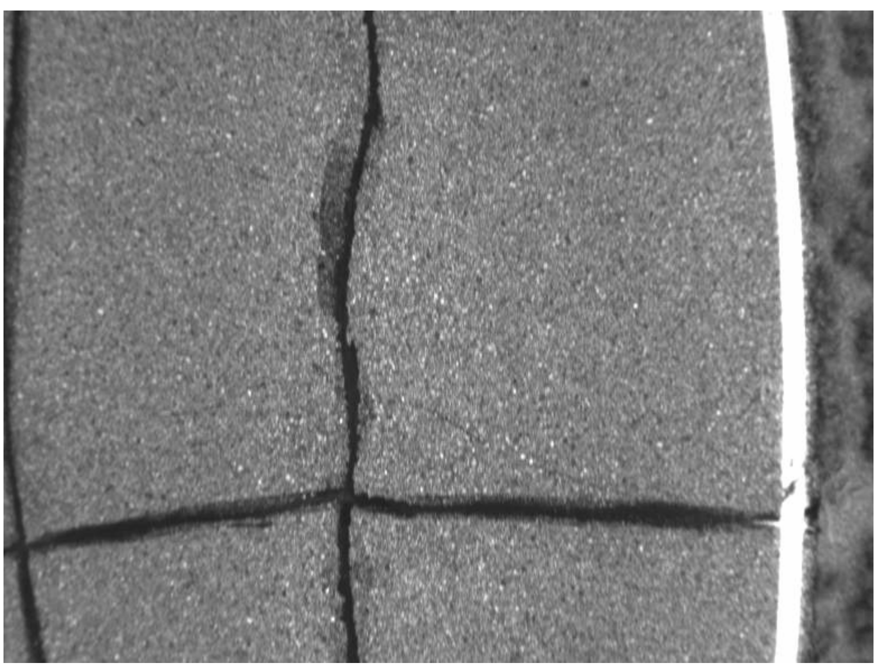

Figure A.18.4. Longitudinal and transverse cracks in R 60 test section, Winnebago County

A.19. S 14, Story County

Location of Test Section

As shown in Figure A.19.1, the test section located on S 14, Story County was constructed in 2003. The beginning and end points of the test section are shown in Figure A.19.2 and 3.19.3, respectively.

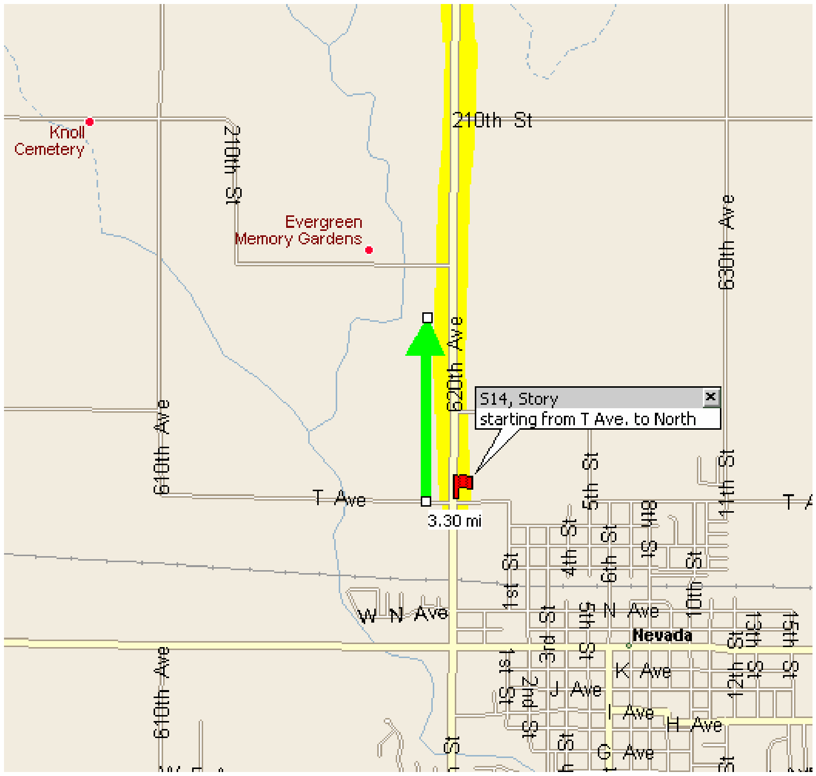

Figure A.19.1. Location of S 14 test section, Story County

Figure A.19.2. Beginning point of S 14 test section, Story County

Figure A.19.3. End point of S 14 test section, Story County

Current Evaluation

On November 27, 2004, at 1 year since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.19.1. As shown in Table A.19.1, no cracking appeared on the test section. The test section exhibited a PSI value of 100, a PCI value of 100 resulting in an average value of 100. Figure A.19.4 shows a sample digital image of the test section acquired using the AICS.

Table A.19.1. Current performance data of S 14 test section, Story County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	0	0	0	0	0	100	100	100

(Unit: ft. or ft^2/100 ft.)

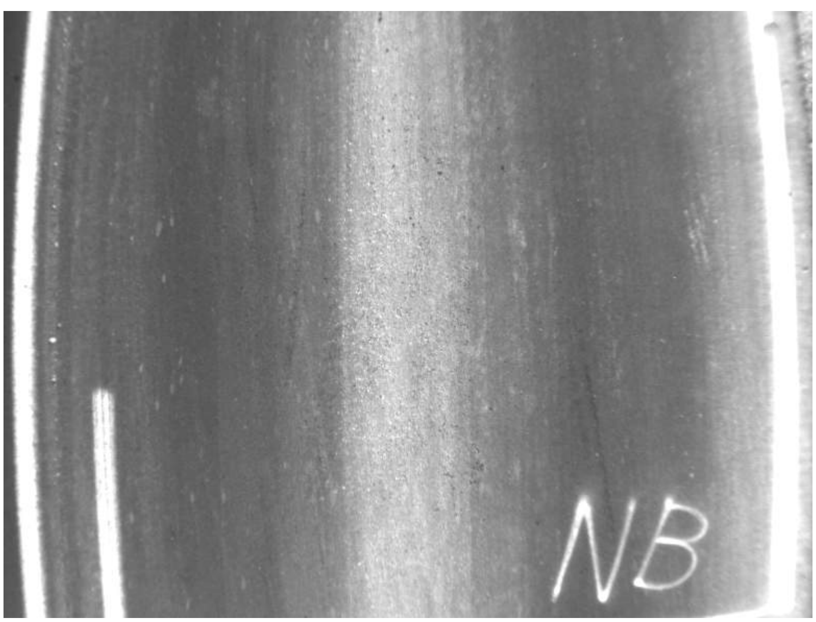

Figure A.19.4. Sample image in S 14 test section, Story County

A.20. S 27, Story County

Location of Test Section

As shown in Figure A.20.1, the test section located on S 27, Story County was constructed in 2003. The beginning and end points of the test section are shown in Figure A.20.2 and 3.20.3, respectively.

Figure A.20.1. Location of S 27 test section, Story County

Figure A.20.2. Beginning point of S 27 test section, Story County

Figure A.20.3. End point of S 27 test section, Story County

Current Evaluation

On November 27, 2004, at 1 year since construction, another distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.20.1. As shown in Table A.20.1, no cracking appeared on the test section. The test section exhibited a PSI value of 100, a PCI value of 100 resulting in an average value of 100. Figure A.20.4 shows a sample digital image of the test section acquired using the AICS.

Table A.20.1. Current performance data of S 27 test section, Story County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	0	0	0	0	0	100	100	100

(Unit: ft. or ft^2/100 ft.)

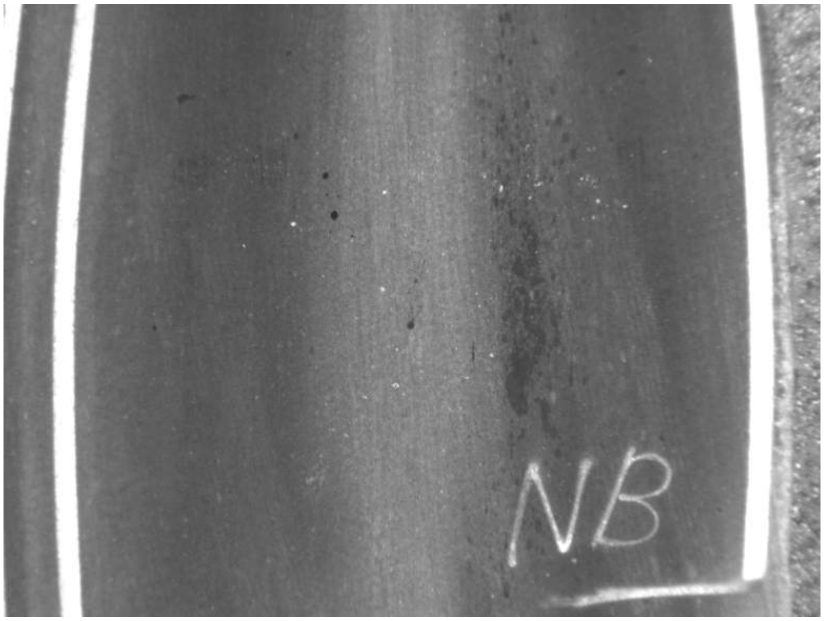

Figure A.20.4. Sample image in S 27 test section, Story County

A.21. North of Breda, Carroll County

Location of Test Section

As shown in Figure A.21.1, the test section located on North of Breda, Carroll County whose construction information was not available. The beginning and end points of the test section are shown in Figure A.21.2 and 3.21.3, respectively.

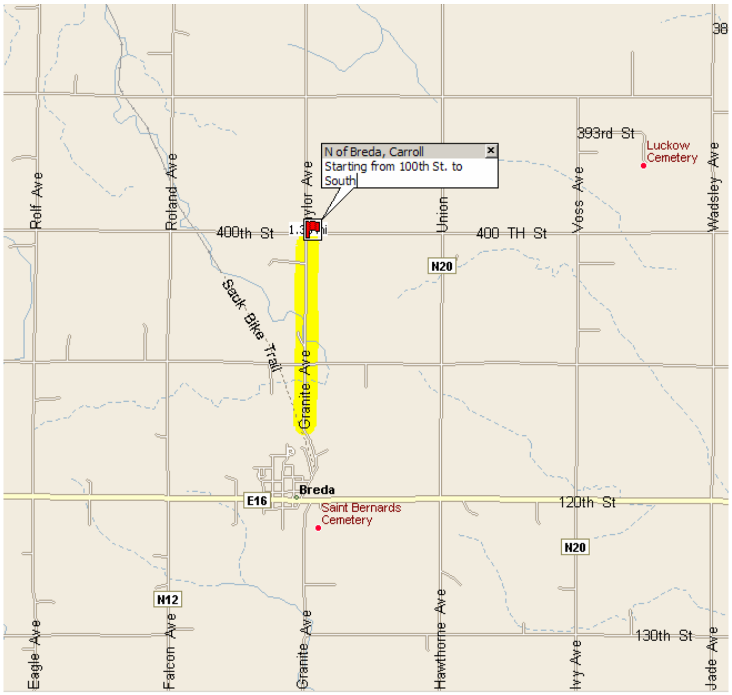

Figure A.21.1 Location of North of Breda test section, Carroll County

Figure A.21.2. Beginning point of North of Breda test section, Carroll County

Figure A.21.3. End point of North of Breda test section, Carroll County

Current Evaluation

On February 13, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.21.1. As shown in Table A.21.1, the most dominant type of distress was transverse cracking with an average length of 7 ft. per 100 ft. station. An edge cracking length is computed as 3 ft. per 100 ft. station. The test section exhibited a PSI value of 88, a PCI value of 99 resulting in an average value of 94. Figure A.21.4 shows a sample digital image of transverse crack acquired using the AICS.

Table A.21.1. Current performance data of North of Breda test section, Carroll County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	7	0	0	3	0	88	99	94

(Unit: ft. or ft^2/100 ft.)

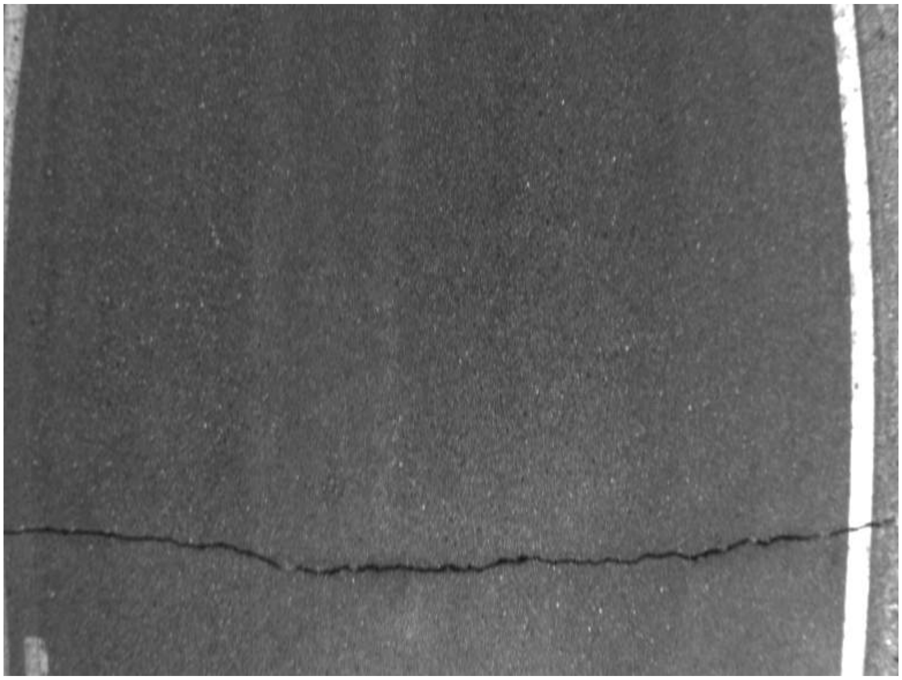

Figure A.21.4. Transverse crack in North of Breda test section, Carroll County

A.22. N 58, Carroll County

Location of Test Section

As shown in Figure A.22.1, the test section located on N 58, Carroll. The beginning and end points of the test section are shown in Figure A.22.2 and 3.22.3, respectively.

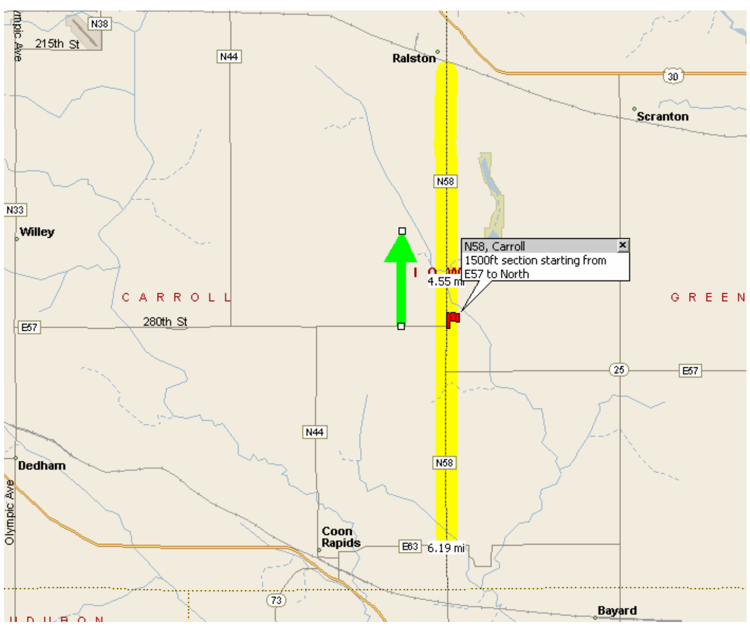

Figure A.22.1. Location of N 58 test section, Carroll County

Figure A.22.2. Beginning point of N 58 test section, Carroll County

Figure A.22.3. End point of N 58 test section, Carroll County

Current Evaluation

On February 13, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.22.1. As shown in Table A.22.1, no cracking appeared on the test section. The test section exhibited a PSI value of 100, a PCI value of 100 resulting in an average value of 100. Figure A.22.4 shows a sample digital image of the test section acquired using the AICS.

Table A.22.1. Current performance data of N 58 test section, Carroll County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	0	0	0	0	0	100	100	100

(Unit: ft. or ft^2/100 ft.)

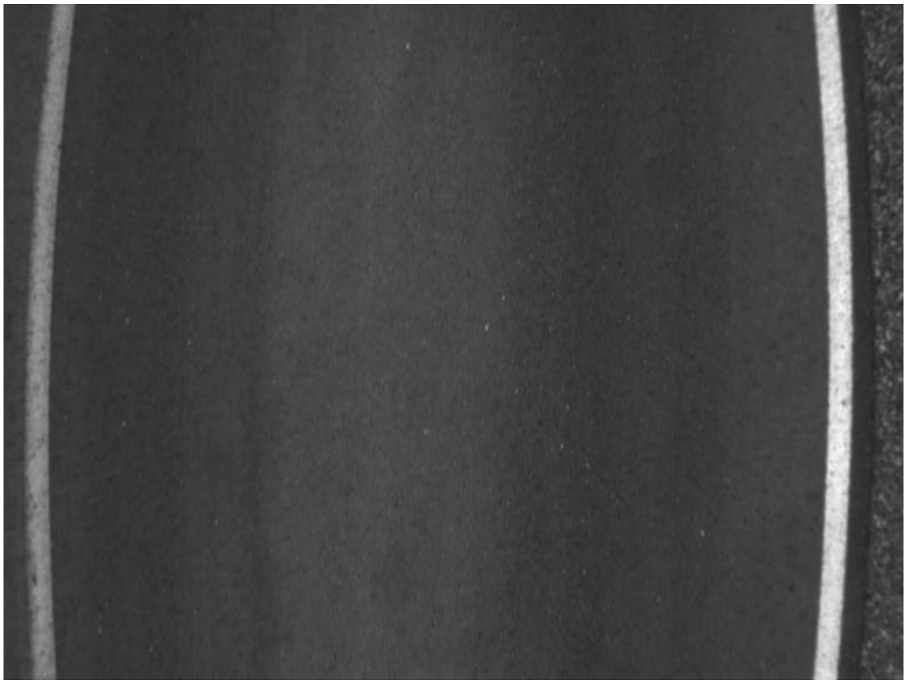

Figure A.22.4. Sample image in N 58 test section, Carroll County

A.23. IA 44, Harrison County

Location of Test Section

As shown in Figure A.23.1, the test section located on IA 44, Harrison County. The beginning and end points of the test section are shown in Figure A.23.2 and 3.23.3, respectively.

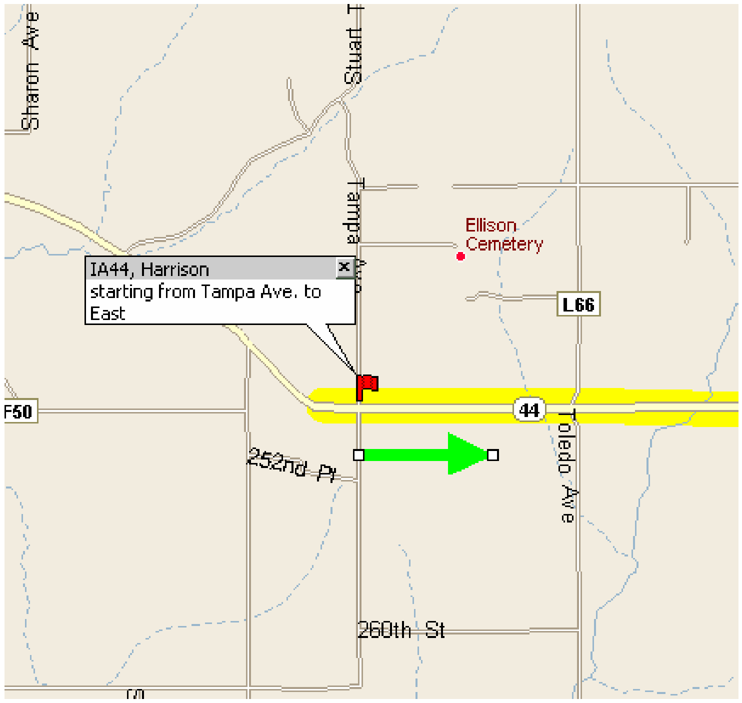

Figure A.23.1. Location of IA 44 test section, Harrison County

Figure A.23.2. Beginning point of IA 44 test section, Harrison County

Figure A.23.3. End point of IA 44 test section, Harrison County

Current Evaluation

On February 13, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.23.1. As shown in Table A.23.1, it had only transverse cracking with an average length of 1 ft. per 100 ft. station. The test section exhibited a PSI value of 90, a PCI value of 100 resulting in an average value of 95. Figure A.23.4 shows a sample digital image of transverse crack acquired using the AICS.

Table A.23.1. Current performance data of IA 44 test section, Harrison County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	1	0	0	0	0	90	100	95

(Unit: ft. or ft^2/100 ft.)

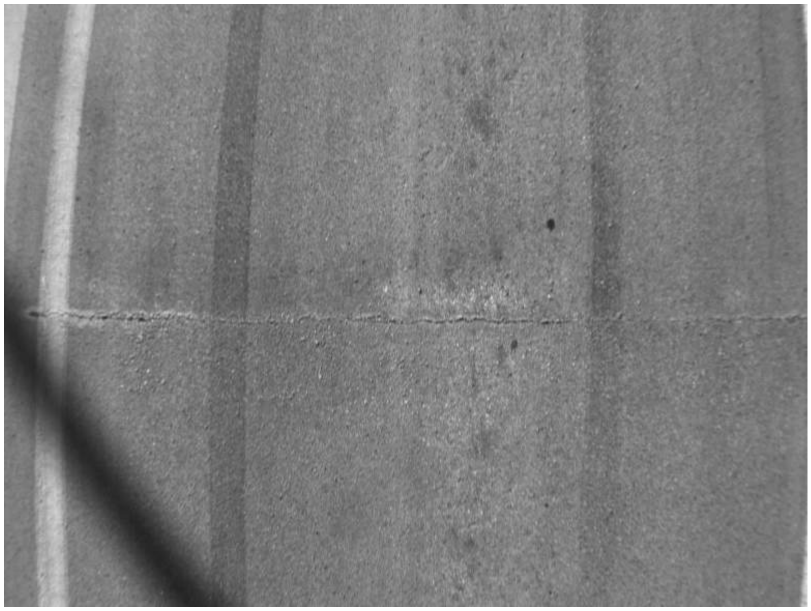

Figure A.23.4 Transverse Crack in IA 44 test section, Harrison County

A.24. IA 48, Montgomery County

Location of Test Section

As shown in Figure A.24.1, the test section located on IA 48, Montgomery. The beginning and end points of the test section are shown in Figure A.24.2 and 3.24.3, respectively.

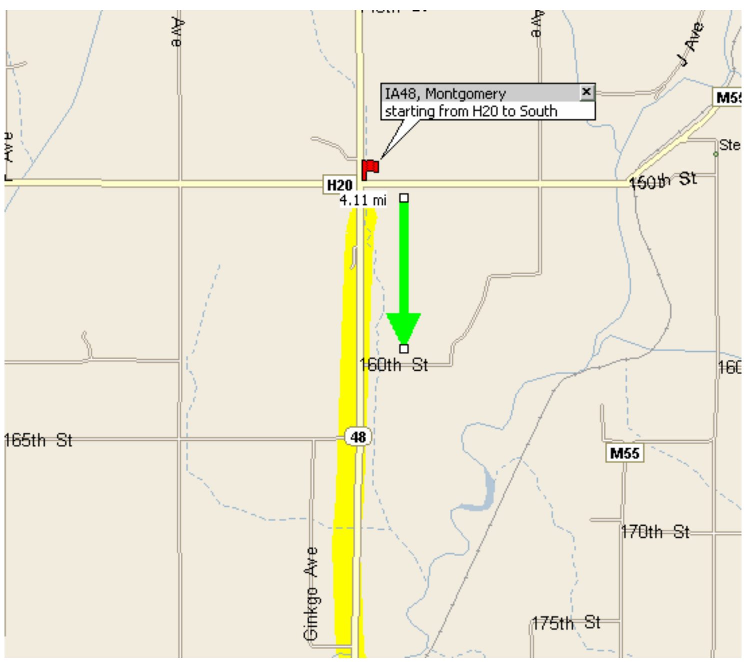

Figure A.24.1. Location of IA 48 test section, Montgomery County

Figure A.24.2. Beginning point of IA 48 test section, Montgomery County

Figure A.24.3. End point of IA 48 test section, Montgomery County

Current Evaluation

On February 13, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.24.1. As shown in Table A.24.1, no distress appeared on the test section. The test section exhibited a PSI value of 95, a PCI value of 100 resulting in an average value of 98. Figure A.24.4 shows a sample digital image of the test section acquired using the AICS.

Table A.24.1. Current performance data of IA 48 test section, Montgomery County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	0	0	0	0	0	0	95	100	98

(Unit: ft. or ft^2/100 ft.)

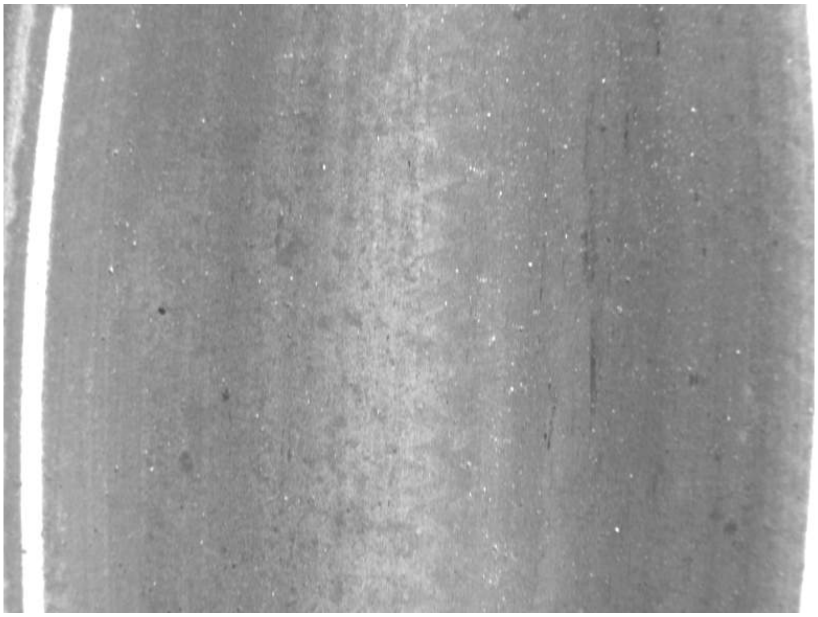

Figure A.24.4. Sample image in IA 48 test section, Montgomery County

A.25. US 20, Delaware County

Location of Test Section

As shown in Figure A.25.1, the test section located on US 20, Delaware. The beginning point of the test section is shown in Figure A.25.2.

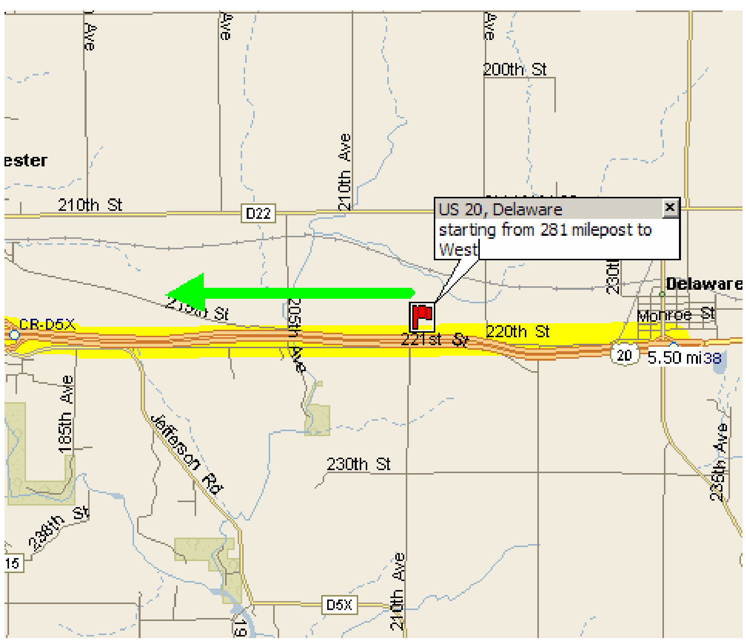

Figure A.25.1. Location of US 20 test section, Delaware County

Figure A.25.2. Beginning point of US 20 test section, Delaware County

Current Evaluation

On February 22, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.25.1. As shown in Table A.25.1, the most dominant type of distress was longitudinal cracking with an average length of 52 ft. per 100 ft. station. Rutting wasn't measured due to very high traffic volume. The test section exhibited a PSI value of 88, a PCI value of 91 resulting in an average value of 90. Figure A.25.3 shows a sample digital image of longitudinal crack.

Table A.25.1. Current performance data of US 20 test section, Delaware County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
0	52	0	10	0	0	0	88	91	90

(Unit: ft. or ft^2/100 ft.)

Figure A.25.3. Longitudinal rack in US 20 test section, Delaware County

A.26. US 61, Jackson County

Location of Test Section

As shown in Figure A.26.1, the test section located on US 61, Jackson. The beginning and end points of the test section are shown in Figure A.26.2 and 3.26.3, respectively.

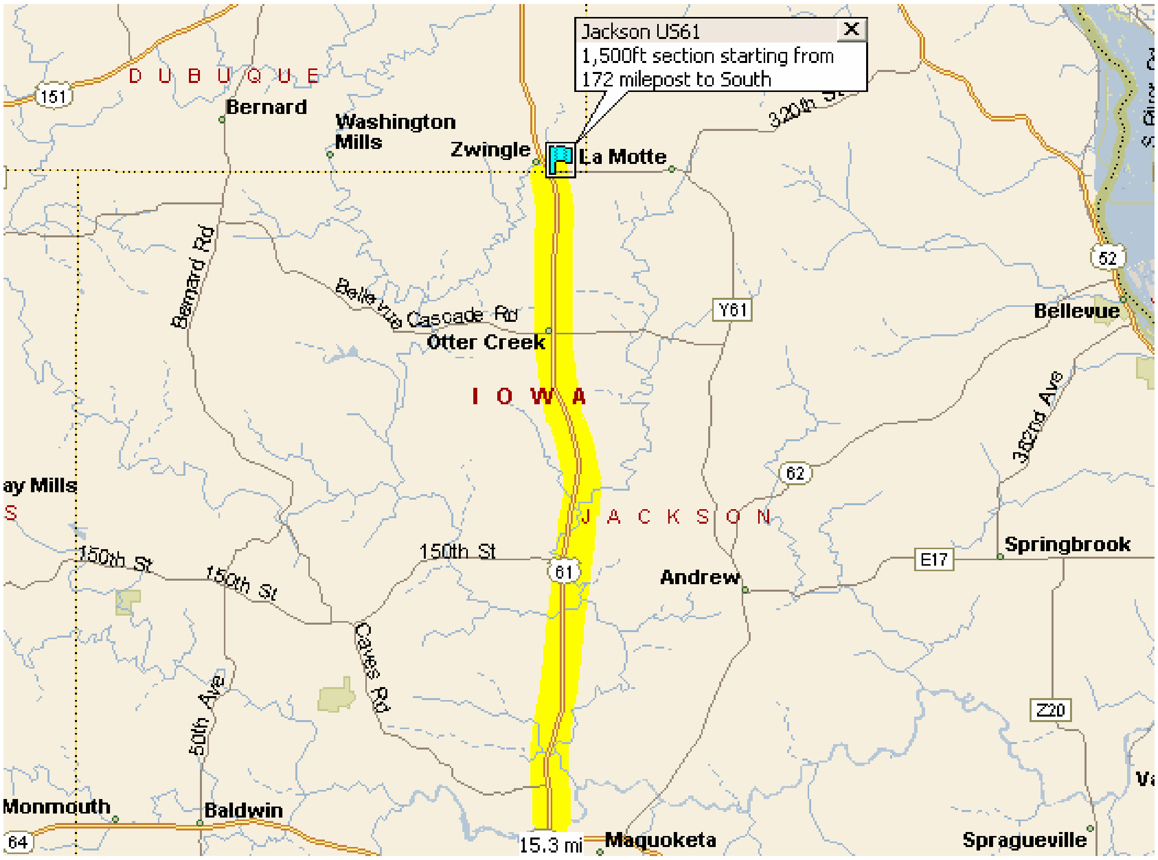

Figure A.26.1. Location of US 61 test section, Jackson County

Figure A.26.2. Beginning point of US 61 test section, Jackson County

Figure A.26.3. End point of US 61 test section, Jackson County

Current Evaluation

On February 22, 2005, distress survey was conducted using an AICS and a rutting device and the survey results are summarized in Table A.26.1. As shown in Table A.26.1, the most dominant type of distress was alligator cracking with an average area of 1.7 ft^2 per 100 ft. station. A rutting area is computed as 35 ft^2 per 100 ft. station. The test section exhibited a PSI value of 88, a PCI value of 87 resulting in an average value of 88. Figure A.26.4 shows a sample digital image of alligator crack.

Table A.26.1. Current performance data of US 61 test section, Jackson County

Rutting	Longitudinal	Transverse	Alligator	Block	Edge	Patching	PSI	PCI	Total
35	0	0	2	0	0	0	88	87	88

(Unit: ft. or ft^2/100 ft.)

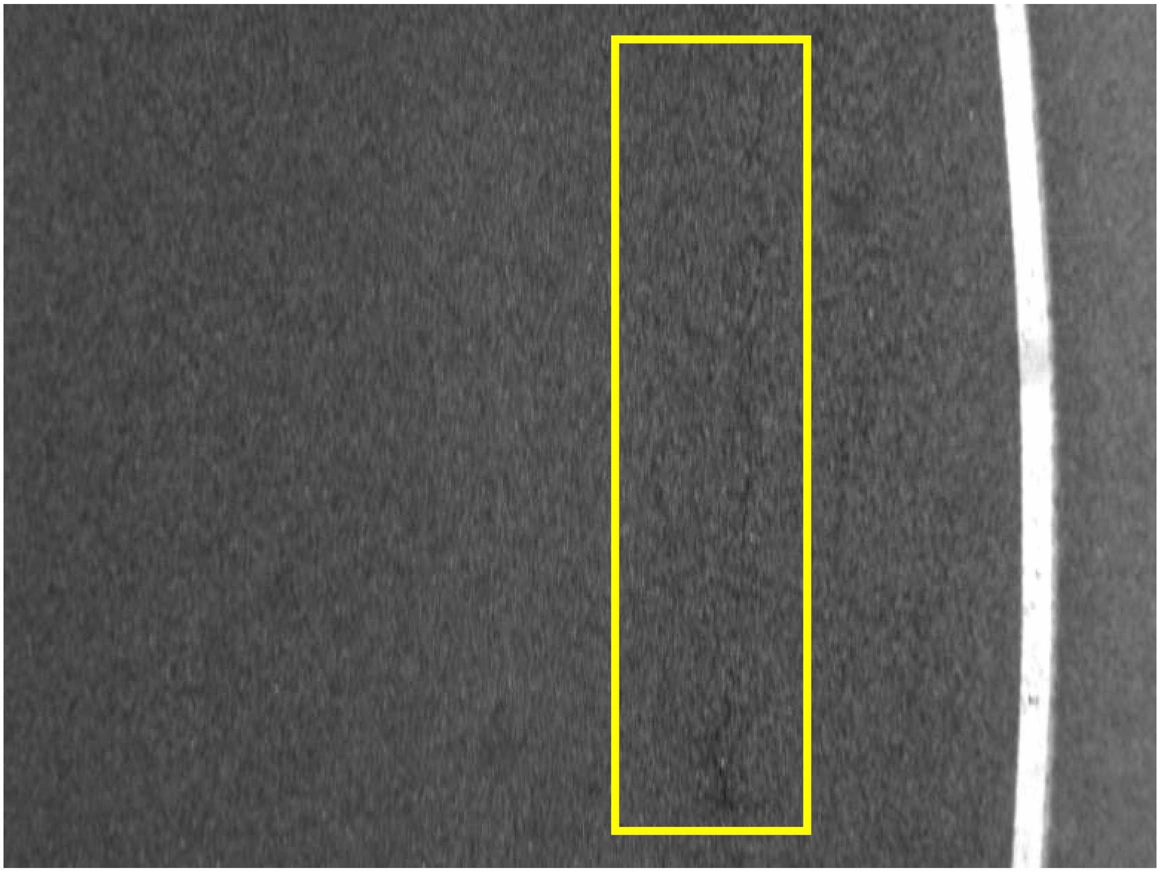

Figure A.26.4. Alligator crack in US 61 test section, Jackson County