Assessment of the SPS-7 Bonded Concrete Overlays Experiment: Final Report

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FOREWORD

The Long Term Pavement Performance (LTPP) program Specific Pavement Studies 7 (SPS-7) experiment was undertaken to explore the use of bonded concrete overlays as a means for rehabilitating concrete pavements. However, only four of the planned 12 SPS-7 projects were built. This report documents an assessment of the SPS-7 experiment as it exists today. It was prepared to provide a factual basis for discussions, with the participating State highway agencies and other agencies involved in research concerned with bonded concrete overlays, as to how we might best use them to maximize our learning on this important topic.

Due to the nature of this report, broad dissemination is not planned. Copies will be provided to the States participating in the SPS-7 and other bonded concrete overlay experiments. Others may obtain the report through the National Technical Information Service.

Charles J. Nemmers, P.E.
Director, Office of Engineering
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NOTICE

Technical Report Documentation Page

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16. Abstract

This report presents an assessment of the Long-Term Pavement Performance (LTPP) SPS-7 experiment. This report is intended to serve as background material for a meeting of State agencies to be held to review the status of the SPS-7 experiment.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3

NOTE Volumes greater than 1000 l shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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SPS-7 BONDED CONCRETE OVERLAYS

INTRODUCTION

Bonded concrete overlays are used to provide structural strengthening to existing concrete pavements to extend the service life of the pavement. Over the years, many studies have been conducted to improve the design and construction techniques for bonded concrete overlays that would result in improved pavement performance over the design service life of the pavement. A primary requirement for bonded concrete overlays is that the overlay and the existing pavement behave as a monolithic structure. Failure to do so will result in premature failures of the overlay because of high stresses that would develop in the overlay acting independently. Thus, it is very important that adequate bond exists at the interface between the overlay and the existing pavement. One of the major drawbacks of a bonded concrete overlay system is the potential for delamination at the interface between the overlay and the existing pavement. The development of delamination is dependent on many factors, the most important being surface preparation, bonding grout used, curing procedures used, and timely sawing of joints as needed in the overlay.

The SPS-7 experiment is aimed at the study of techniques to achieve adequate bonding at the interface between the overlay and the existing concrete, the effects of various factors on the degree of bonding achieved, and the affect of the degree of bonding on the long-term performance of the overlaid pavement. In addition, the experiment also incorporates two levels of overlay thickness to study the effect of overlay thickness on long-term performance of the overlaid pavement.

To date, only four SPS-7 projects have been constructed. Since the SPS-7 experiment has not been populated as planned, a study was undertaken to review the status of the experiment with primary emphasis on future usefulness of the SPS-7 experiment within the context of the national Long-Term Pavement Performance (LTPP) program.

BACKGROUND

The SPS-7 study was developed specifically to study the effects of method of surface preparation prior to resurfacing, use of cement grout, and overlay thickness on the long-term performance of rehabilitated portland cement concrete (PCC) pavements. The experimental design called for a total of 96 bonded overlay test sections and 12 control test sections to be constructed at 12 project sites. Three project sites were to be located in each of the four environmental regions. The three SPS-7 project sites in each environmental region were to incorporate two existing jointed plain concrete pavement (JPCP) projects and one continuously reinforced concrete pavement (CRCP) project. As such, the SPS-7 experiment was also designed to examine the effect of climate, type of existing pavement, condition of existing pavement, and traffic as covariants. The experiment design stipulated a traffic loading level in the study lane in excess of 200,000 equivalent single axle loads (ESAL's) per year. The experimental design for SPS-7 is presented in table 1. Specific details of test sections at each project are given in table 2.

The recruitment of SPS-7 project sites began during 1989. However, to date only four projects have been constructed, and no additional SPS-7 projects are expected to be constructed. The basic details of the four projects are given in table 3.

As with most other LTPP test sections/projects, five categories of data are being collected from the SPS-7 projects. These are:

1. Inventory data.
2. Materials data.
3. Climatic data.
4. Monitoring data.
5. Traffic data.

The monitoring data include surface distress survey data obtained manually and by interpreting photographic images. Although the distress surveys account for typical concrete pavement distresses, these surveys and other routine field monitoring activities do not evaluate or identify the extent of delamination or degree of bonding between the overlay and the existing pavement.

In the following sections, the four SPS-7 projects are described in detail and an assessment is provided on the availability and quality of data for these four projects. The scope of work for this study did not include data analysis.

SPS-7 PROJECT DETAILS

Some of the relevant data for the four SPS-7 projects are provided in this section. More detailed information on these projects is given in references 1, 2, 3, and 4.

Missouri SPS-7 Project

Original Pavement:
- JPCP constructed in 1955.
- Thickness - 254 mm.
- Joint spacing - 6.1 m.
- Joint type - non-doweled.
- Base - 102-mm crushed limestone.
- Subgrade - clay.
- Shoulder type - asphalt concrete (AC).
- Traffic pattern - part of a 2-lane, 2-way roadway; since 1971, part of northbound lanes.

Table 1. Experiment design for SPS-7.

Overlay Factors			Moisture, Temperature, and Pavement Type											
			Wet						Dry					
			Freeze			No-Freeze			Freeze			No-Freeze		
Surface Preparation	Used Grout	Overlay Thickness, mm	JCP		CRCP	JCP		CRCP	JCP		CRCP	JCP		CRCP
			1	2	3	4	5	6	7	8	9	10	11	12
Cold Milling plus Sand Blasting	No	76	X	X	X	X	X	X	X	X	X	X	X	X
		127	X	X	X	X	X	X	X	X	X	X	X	X
	Yes	76	X	X	X	X	X	X	X	X	X	X	X	X
		127	X	X	X	X	X	X	X	X	X	X	X	X
Shot Blasting	No	76	X	X	X	X	X	X	X	X	X	X	X	X
		127	X	X	X	X	X	X	X	X	X	X	X	X
	Yes	76	X	X	X	X	X	X	X	X	X	X	X	X
		127	X	X	X	X	X	X	X	X	X	X	X	X

Each X designates a test section.

JCP = Jointed concrete pavement.
CRCP = Continuously reinforced concrete pavement.

Table 2. Test section layout at each SPS-7 site.

Section Number	Surface Preparation	Grout Use	Overlay Thickness, mm
701	Control	---	---
702	Milling	Yes	76.2
703	Milling	No	76.2
704	Shot Blasting	No	76.2
705	Shot Blasting	Yes	76.2
706	Shot Blasting	Yes	127.0
707	Shot Blasting	No	127.0
708	Milling	No	127.0
709	Milling	Yes	127.0

Note: Secondary cleaning, such as sand blasting, was required for the milling technique. Final cleaning using air blasting or mechanical sweepers was required of all prepared surfaces.

Table 3. SPS-7 project sites.

State	Date Original Pavement Constructed	Date Overlay Constructed	Existing Pavement Type	Original Pavement Thickness, mm	Environmental Region	Weigh-in-Motion (WIM) Installed
Missouri	1955	July 1990	JPCP	203	Wet-Freeze	Yes
Minnesota	1970	October 1990	CRCP	203	Wet-Freeze	Yes
Louisiana	1979	April 1992	CRCP	203	Wet-No Freeze	---
Iowa	1967	August 1992	CRCP	203	Wet-Freeze	Yes

Overlay Sections:
Constructed – July 1990.
No. of sections – 9 SPS-7 required; 9 agency-designed.

Traffic – 6300 to 6500 Average Annual Daily Traffic (AADT) (1988); 11 percent trucks; 213,000 to 253,000 ESAL's.

Pre-overlay repairs	–	Full-depth patching.
Pre-overlay condition survey	–	Stitching across cracks.
Non-routine testing performed by agency	–	Yes.
	–	Maturity meter testing.
	–	Iowa shear test and tension pull-off tests.
	–	Delamination surveys.
Overlay curing details	–	Curing compound used.
	–	Curing blankets used after 4 days and not after 4 hours, as stipulated in contract.
Specific construct time and early age observations	–	Section 290708 was not sandblasted after milling. Dust deposits present prior to grouting and overlaying. Section 290708 exhibited some debonding at 2 days and 24 percent debonding at 60 days.
	–	At 60 days, sections 290706 and 290707 had exhibited complete debonding.
	–	sections 290704 and 290705 exhibited 28 percent and 16 percent debonding, respectively, at 60 days.

Minnesota SPS-7 Project

Original Pavement:
CRCP constructed in 1970.
Thickness – 203 mm.
Base/Subbase – 76-mm soil aggregate base; 305-mm sand subbase.
Steel Reinforcement – data missing.
Subgrade – clay.
Shoulder type – AC.

Overlay Sections:
Constructed – October 1990.
No. of sections – 9 SPS-7 required; 1 agency-designed.

Traffic – 2-way AADT of 16,000 vehicles (2011 est.); 21 percent trucks; study lane ESAL data not available.

Pre-overlay repairs	–	No details available.
Pre-overlay condition survey	–	Photographic distress survey performed.

Non-routine testing performed by agency	-	No details available.
Overlay curing details	-	No details available.
Specific construct time and early age observations	-	No details available.

Louisiana SPS-7 Project

Original Pavement:

CRCP constructed in 1979.
Thickness - 203 mm.
Base/Subbase - 102-mm hot mix AC (HMAC); 152-mm lime-treated subbase.
Steel Reinforcement - data missing.
Subgrade - 2.1 m fill silty clay.
Shoulder type - tied PCC shoulder.

Overlay Sections:

Constructed - April 1992.
No. of sections - 8 SPS-7 required (no control section).

Traffic - 2-way AADT of 24,000 vehicles (1989); 15 percent trucks; 550 ESAL's/year in study lane.

Pre-overlay repairs	-	Full-depth patching.
Pre-overlay condition survey	-	Yes.
Non-routine testing performed by agency	-	No details available.
Overlay curing details	-	No details available.
Specific construct time and early age observations	-	Water blasting used for secondary cleaning for milled sections. Construction joints in section 220709. Overlay thicknesses larger than specified.

Iowa SPS-7 Project

Original Pavement:

CRCP constructed in 1967.
Thickness - 203 mm.
Base/Subbase - 102-mm crushed stone base; 610-mm sandy clay subbase.
Steel Reinforcement - data missing.
Subgrade - sandy clay.
Shoulder type - AC.

Overlay Sections:

Constructed - August 1992.
No. of sections - 9 SPS-7 required; 1 agency-designed.

Traffic - 2-way AADT of 11,400 vehicles (early 1990's); 29 percent trucks; 668,000 ESAL's in study lane.

Pre-overlay repairs	-	Full-depth patching.
Pre-overlay condition survey	-	Yes.
Non-routine testing performed by agency	-	No details available.
Overlay curing details	-	No details available.
Specific construct time and early age observations	-	Overlays were thicker than specified at several locations.

ASSESSMENT OF SPS-7 DATABASE

All available SPS-7 data and appropriate tables were obtained from the National Information Management System (NIMS) during August 1997. Not all of the data received from the NIMS were at Level E record status, meaning that some of the data used to assemble the SPS-7 database have not passed all the established quality assurance checks. Data that are at a record level other than E are not made available to the public. Construction reports from each of the SPS-7 project sites were also obtained, along with any other documents relevant to the SPS-7 experiment. All the available data and documentation were reviewed to identify missing and erroneous data that would affect any future analyses. Data categories that were considered in this assessment include the following:

- Pre-Overlay Condition Data.
- Post-Overlay Monitored Data.
- PCC Overlay Construction Data.
- PCC Overlay Thickness.
- Material Test Data.
- PCC Bond Strength Data.
- Traffic Data.
- Deflection Data.
- Delamination Survey Data.

The SPS-7 specific data tables available in NIMS are listed in table 4. A summary of key data availability for each of the four SPS-7 projects is given in tables 5, 6, 7, and 8.

Pre-Overlay Condition Data

Construction reports and data from the NIMS were reviewed to evaluate the completeness of the pre-overlay condition data for the existing PCC pavements at the SPS-7 project sites. Manual or automated distress surveys were required before overlay placement for reference. To date, there is only one project site, Louisiana, with a complete pre-overlay manual distress survey available in the NIMS. The SPS-7 project site at Iowa had approximately 50 percent of the sections manually surveyed prior to overlay construction. The construction report for the

Table 4. SPS-7 specific data tables.

Table Name	Table Description	Comment
SPS7_DELAMINATION	Surface removal/cleaning for PCC surfaces.	
SPS7_INTERSECTIONS	SPS test section information.	No records.
SPS7_LAYER	Layer descriptions.	
SPS7_LAYER_THICKNESS	Layer thickness measurements.	
SPS7_LOAD_TRANSFER	Load transfer restoration data.	No records.
SPS7_MILLING	Milling of PCC surfaces.	
SPS7_NOTES_AND_COMMENT	Section notes and comments.	No records.
SPS7_PCC_CRACK_SEAL	Crack resealing data for PCC surfaces.	No records.
SPS7_PCC_FULL_DEPTH	Full-depth repair data for PCC surfaces.	
SPS7_PCC_JOINT_RESEAL	Joint resealing data for PCC surfaces.	
SPS7_PCC_OVERLAY	PCC overlay placement operations.	
SPS7_PCC_PART_DEPTH	Partial-depth patching data for PCC surfaces.	
SPS7_PCCO_JOINT_DATA	PCC overlay placement operations.	
SPS7_PROJECT_STATIONS	SPS test section information.	
SPS7_QC_MEASUREMENTS	Construction quality control measurements.	
SPS7_REFLECTIVE_CRACK	Reflective crack control data for PCC surfaces.	
SPS7_REMOVAL_CLEANING	Surface removal/cleaning for PCC surfaces.	
SPS7_SUBDRAINAGE	Subdrainage (retrofit) data.	No records.
SPS7_TRANFER_EFFICIENCY	Load transfer restoration data, transfer efficiency.	No records.
SPS7_UNDERSEALING	Undersealing data for PCC surfaces.	No records.

Note: Data table availability was as of August 1997. "No records" means that the data table was provided without any records in the table. Since the other SPS-7 specific data tables provided included Level A to E data, this implies that no data exist for the "no records" tables.

Table 5. Summary of key data availability for the Iowa project.

Data Type	Test Section								
	701	**702**	**703**	**704**	**705**	**706**	**707**	**708**	**709**
Existing Pavement Type	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP
Construction Date	---	08/13/92	08/13/92	08/05/92	08/05/92	08/05/92	08/05/92	08/08/92	08/08/92
Control Section	Yes								
Overlay Thickness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual Distress Survey Before Overlay				7/8/92	7/8/92	7/8/92	7/8/92		
Manual Distress Survey After Overlay	8/23/93	8/26/92	8/26/92	8/26/92	8/26/92	8/26/92	8/26/92	8/26/92	8/26/92
		8/24/93	8/24/93	8/26/93	8/26/93	8/26/93	8/25/93	8/25/93	8/24/93
Photo Distress Survey Before Overlay	4/22/92	4/22/92	4/22/92	4/22/92	4/22/92	4/22/92	4/22/92	4/22/92	4/22/92
Photo Distress Survey After Overlay	5/10/93	5/10/93	5/10/93	5/10/93	5/10/93	5/10/93	5/10/93	5/10/93	5/10/93
	4/2/96	4/2/96	4/2/96	4/2/96	4/2/96	4/2/96	4/2/96	4/2/96	4/2/96
Deflection Before Overlay	7/7/92	7/8/92	7/8/92	7/8/92	7/8/92	7/10/92	7/9/92	7/9/92	7/9/92
Deflection After Overlay	10/6/92	10/6/92	10/6/92	10/8/92	10/8/92	10/8/92	10/5/92	10/7/92	10/7/92
	8/23/93	8/24/93	8/24/93	8/26/93	8/26/93	8/26/93	8/25/93	8/25/93	8/24/93
Traffic (WIM)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bond Strength	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delamination	Yes*	Yes*	Yes*	Yes*		Yes*	Yes*	Yes*	Yes*
Friction	9/17/93	9/17/93	9/17/93	9/17/93	9/17/94	9/17/93	9/17/93	9/17/93	9/17/93
	9/17/94	9/17/94	9/17/94	9/17/94	8/1/95	9/17/94	9/17/94	9/17/94	9/17/94
	8/1/95	8/1/95	8/1/95	8/1/95		8/1/95	8/1/95	8/1/95	8/1/95
Overlay Concrete Elastic Modulus									
Overlay Concrete Tensile Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overlay Flexural Strength									
Overlay Concrete Comp. Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Profile Data	5/10/92	5/10/92	5/10/92	5/10/92	5/10/92	5/10/92	5/10/92	5/10/92	5/10/92
	11/30/93	11/30/93	11/30/93	11/30/93	11/30/93	11/30/93	11/30/93	11/30/93	11/30/93

* Obvious errors exist in data.

Table 6. Summary of key data availability for the Louisiana project.

	Test Section								
Data Type	**701**	**702**	**703**	**704**	**705**	**706**	**707**	**708**	**709**
Existing Pavement Type		CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP
Construction Date		04/29/92	04/29/92	04/29/92	04/29/92	04/24/92	04/24/92	04/24/92	04/22/92
Control Section	No								
Overlay Thickness		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual Distress Survey Before Overlay		4/2/92	4/2/92	4/2/92	4/3/92	4/3/92	4/3/92	4/3/92	4/2/92
Manual Distress Survey After Overlay		12/8/92	12/8/92	12/8/92	12/8/92	12/9/92	12/9/92	12/9/92	12/9/92
		7/12/94	7/12/94	7/12/94	7/12/94	7/12/94	7/12/94	7/12/94	7/12/94
Photo Distress Survey Before Overlay		3/26/92	3/26/92	3/26/92	3/26/92	3/26/92	3/26/92	3/26/92	3/26/92
Photo Distress Survey After Overlay		3/19/93	3/19/93	3/19/93	3/19/93	3/19/93	3/19/93	3/19/93	3/19/93
		1/8/96	1/8/96	1/8/96	1/8/96	1/8/96	1/8/96	1/8/96	1/8/96
Deflection Before Overlay		4/2/92	4/3/92	4/3/92	4/6/92	4/2/92	4/1/92	4/1/92	3/31/92
Deflection After Overlay		12/8/92	12/8/92	12/11/92	12/11/92	12/9/92	12/10/92	12/10/92	12/11/92
Traffic (WIM)		NA	NA	NA	NA	NA	NA	NA	NA
Bond Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delamination									
Friction		8/21/96	8/21/96	8/21/96	8/21/96	8/21/96	8/21/96	8/21/96	8/21/96
Overlay Concrete Elastic Modulus		Yes			Yes	Yes	Yes	Yes	Yes
Overlay Concrete Tensile Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overlay Flexural Strength		Yes	Yes		Yes	Yes		Yes	Yes
Overlay Concrete Comp. Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Profile Data		3/5/92	3/5/92	3/5/92	3/5/92	3/5/92	3/5/92	3/5/92	3/5/92
		1/8/93	1/8/93	1/8/93	1/8/93	1/8/93	1/8/93	1/8/93	1/8/93
		2/6/95	2/6/95	2/6/95	2/6/95	2/6/95	2/6/95	2/6/95	2/6/95

Table 7. Summary of key data availability for the Minnesota project.

Data Type	Test Section								
	701	702	703	704	705	706	707	708	709
Existing Pavement Type	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP	CRCP
Construction Date	---	10/01/90	10/01/90	10/01/90	10/01/90	10/01/90	10/01/90	10/01/90	10/01/90
Control Section	Yes								
Overlay Thickness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual Distress Survey Before Overlay									
Manual Distress Survey After Overlay	8/16/93	6/2/92	6/3/92	6/4/92	6/4/92	6/4/92	6/4/92	6/2/92	8/19/93
	7/10/95	8/17/93	8/17/93	8/17/93	8/18/93	8/18/93	8/18/93	8/19/93	7/13/95
		7/11/95	7/11/95	7/11/95	7/12/95	7/12/95	7/12/95	7/13/95	
Photo Distress Survey Before Overlay		5/14/90	5/14/90	5/14/90	5/14/90	5/14/90	5/14/90	5/14/90	5/14/90
Photo Distress Survey After Overlay	10/6/91	10/6/91	10/6/91	10/6/91	10/6/91	10/6/91	10/6/91	10/6/91	10/6/91
	6/1/93	6/1/93	6/1/93	6/1/93	6/1/93	6/1/93	6/1/93	6/1/93	6/1/93
	6/19/96	6/19/96	6/19/96	6/19/96	6/19/96	6/19/96	6/19/96	6/19/96	6/19/96
Deflection Before Overlay	8/29/90	8/29/90	8/29/90	8/29/90	8/29/90	8/30/90	8/30/90	8/30/90	8/30/90
Deflection After Overlay	11/14/90	11/14/90	11/14/90	11/14/90	11/14/90	11/15/90	11/15/90	11/15/90	11/15/90
	9/10/91	9/10/91	9/10/91	9/11/91	9/11/91	9/11/91	9/12/91	9/12/91	9/12/91
	6/3/92	6/3/92	6/3/92	6/4/92	6/4/92	6/4/92	6/4/92	6/2/92	6/2/92
	8/16/93	8/17/93	8/18/93	8/18/93	8/18/93	8/18/93	8/19/93	8/19/93	8/19/93
	7/10/95	7/11/95	7/11/95	7/11/95	7/12/95	7/12/95	7/12/95	7/13/95	7/13/95
Traffic	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**
Bond Strength									
Delamination									
Friction									
Overlay Concrete Elastic Modulus									
Overlay Concrete Tensile Strength									
Overlay Flexural Strength									
Overlay Concrete Comp. Strength									
Profile Data	8/9/91	6/24/90	6/24/90	6/24/90	6/24/90	6/24/90	6/24/90	6/24/90	6/24/90
	11/20/93	8/9/91	8/9/91	8/9/91	8/9/91	8/9/91	8/9/91	8/9/91	8/9/91
	7/28/94	10/31/92	10/31/92	10/31/92	10/31/92	10/31/92	10/31/92	10/31/92	10/31/92
		11/20/93	11/20/93	11/20/93	11/20/93	11/20/93	11/20/93	11/20/93	11/20/93
		7/28/94	7/28/94	7/28/94	7/28/94	7/28/94	7/28/94	7/28/94	7/28/94

** Traffic data exists only before 1992.

Table 8. Summary of key data availability for the Missouri project.

Data Type	Test Section								
	701	702	703	704	705	706	707	708	709
Existing Pavement Type	JPCP	JPCP	JPCP	JPCP	JPCP	JPCP	JPCP	JPCP	JPCP
Construction Date	---	06/29/90	06/22/90	06/26/90	06/29/90	07/03/90	07/02/90	07/02/90	07/02/90
Control Section	Yes								
Overlay Thickness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual Distress Survey Before Overlay									
Manual Distress Survey After Overlay	7/24/91	7/23/91	7/23/91	7/24/91	7/24/91	7/25/91	7/25/91	7/24/91	7/25/91
	6/22/92	6/23/92	6/23/92	6/23/92	6/23/92	6/23/92	6/23/92	6/23/92	6/23/92
	5/6/93	5/10/93	5/6/93	5/7/93	5/10/93	5/11/93	5/10/93	5/10/93	5/10/93
	9/15/94	9/15/94	9/16/94	9/19/94	9/19/94	9/26/95	9/21/94	9/20/94	9/21/94
	9/25/95	9/20/94	9/25/95	9/27/95	9/27/95		9/26/95	9/26/95	9/26/95
		9/28/95							
Photo Distress Survey Before Overlay	4/19/90	4/19/90	4/19/90	4/19/90	4/19/90	4/19/90	4/19/90	4/19/90	4/19/90
Photo Distress Survey After Overlay	5/13/91	5/13/91	5/13/91	5/13/91	5/13/91	5/13/91	5/13/91	5/13/91	5/13/91
	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91
	3/28/93	3/28/93	3/28/93	3/28/93	3/28/93	3/28/93	3/28/93	3/28/93	3/28/93
	3/25/96	3/25/96	3/25/96	3/25/96	3/25/96	3/25/96	3/25/96	3/25/96	3/25/96
Deflection Before Overlay	5/16/90	5/14/90	5/14/90	5/17/90	5/14/90	5/18/90	5/18/90	5/17/90	5/17/90
	5/17/90								
Deflection After Overlay	11/5/90	11/5/90	11/5/90	11/5/90	11/6/90	11/6/90	11/6/90	11/6/90	11/6/90
	8/23/91	6/22/92	8/23/91	8/26/91	8/26/91	6/25/92	8/27/91	8/27/91	8/27/91
	6/22/92	5/10/93	6/22/92	6/23/92	6/23/92	5/11/93	6/25/92	6/24/92	6/24/92
	5/6/93	9/20/94	5/6/93	5/7/93	5/10/93	9/22/94	5/11/93	5/10/93	5/11/93
	9/15/94		9/16/94	9/19/94	9/19/94		9/21/94	9/20/94	9/21/94
Traffic (WIM)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bond Strength	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Faulting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delamination		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Friction	7/24/91	7/24/91	7/24/91	7/24/91	7/24/91	7/24/91	7/24/91	7/24/91	7/24/91
	8/18/92	8/18/92	8/18/92	8/18/92	8/18/92	8/18/92	8/18/92	8/18/92	8/18/92
	10/5/93	10/5/93	10/5/93	10/5/93	10/5/93	10/5/93	10/5/93	10/5/93	10/5/93
	8/29/94	8/29/94	8/29/94	8/29/94	8/29/94	8/29/94	8/29/94	8/29/94	8/29/94
	7/25/96	7/25/96	7/25/96	7/25/96	7/25/96	7/25/96	7/25/96	7/25/96	7/25/96
Overlay Concrete Elastic Modulus						Yes	Yes	Yes	
Overlay Concrete Tensile Strength							Yes	Yes	
Overlay Flexural Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overlay Concrete Comp. Strength		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Profile Data	4/6/90	4/6/90	4/6/90	4/6/90	4/6/90	4/6/90	4/6/90	4/6/90	3/13/91
	3/13/91	3/13/91	3/13/91	3/13/91	3/13/91	3/13/91	3/13/91	3/13/91	2/18/92
	2/18/92	2/18/92	2/18/92	2/18/92	2/18/92	2/18/92	2/18/92	2/18/92	3/16/94
	3/16/94	3/16/94	3/16/94	3/16/94	3/16/94	3/16/94	3/16/94	3/16/94	

* Although construction records indicate pre-overlay manual distress surveys were performed, no data exists in the NIMS.

Missouri project states that distress surveys were completed prior to the placement of the overlay. However, no records of the results for the pre-overlay condition surveys of the SPS-7 site in Missouri are available in the NIMS. No manual survey was performed at the Minnesota SPS-7 project site.

The only two photographic distress surveys that were performed prior to the construction of the concrete overlay are for the Minnesota and Missouri project sites. The photographic distress surveys cannot be relied upon to provide reliable information on transverse cracking in CRCP.

Post-Overlay Monitored Data

Data from the NIMS were reviewed to evaluate the completeness of the data concerning the post-overlay condition of the SPS-7 project sites. Manual distress surveys following the placement of the overlay were available in the NIMS for all four SPS-7 project sites to varying degrees. A total of five post-overlay manual distress surveys have been completed and uploaded to NIMS for all the sections at the project site in Missouri. Three post-overlay manual distress surveys have been completed and uploaded to NIMS for most of the sections at the project site in Minnesota. Two post-overlay manual distress surveys have been completed and uploaded to NIMS for all the sections at the project site in Louisiana. Two post-overlay manual distress surveys have been completed and uploaded to NIMS for about 50 percent of the sections at the project site in Iowa. With respect to photographic distress surveys, as shown in tables 5 to 8, at least two rounds of post-overlay surveys have been performed at each SPS-7 project site. Of these surveys, only those surveys performed during 1996 have recently been interpreted. But these data are not yet available in the NIMS. However, as noted earlier, the photographic surveys cannot be relied upon to provide reliable information on transverse cracking in CRCP.

Tables 9 to 12 present data on the total number of transverse cracks across all severity levels that were recorded in the post-overlay condition surveys for each of the project sites. All the data in tables 9 to 12 were taken from the manual surveys stored in the NIMS, with the exception of one survey at the Minnesota site and one survey at the Missouri site. These two exceptions are data from the automated pre-overlay surveys (PADIAS) stored in the NIMS.

Upon closer inspection of the total transverse cracking data in tables 9 through 12, several observations can be made concerning the quantity and quality of the condition data collected for the four SPS-7 project sites. There was no control section incorporated in the Louisiana project site. The condition data available in some cases are of questionable accuracy. It should also be noted that the photographic survey procedure is not considered very reliable for identifying low-severity transverse cracking in PCC pavements. Thus, any assessment of transverse cracking data obtained using photographic surveys must be done with caution.

The condition data collected for the Iowa project site follows typical trends in crack development following a structural overlay. The amount of data collected prior to the placement of the PCC overlay is lacking, as only 50 percent of the sections were surveyed. Only two post-overlay manual condition surveys are currently stored in the NIMS, with none undertaken more

Table 9. Number of transverse cracks at Iowa project site (manual surveys).

Section Number	Prior to Overlay	Immediately After Overlay	12 Months After Overlay
701			237
702		37	71
703		6	81
704	123	6	50
705	204	1	36
706	129	39	96
707	111	52	52
708		53	97
709		59	102

Table 10. Number of transverse cracks at Louisiana project site (manual surveys).

Section Number	Prior to Overlay	8 Months After Overlay	26 Months After Overlay
702	126	78	87
703	141	60	85
704	140	67	104
705	146	59	86
706	88	84	89
707	94	78	86
708	87	91	95
709	95	126	128

Table 11. Number of transverse cracks at Minnesota project site.

Section Number	Prior to Overlay	20 Months After Overlay (Manual Survey)	34 Months After Overlay (Manual Survey)	57 Months After Overlay (Manual Survey)
701			430	394
702	151	77	110	97
703	166	97	106	119
704	177	94	112	115
705	266	93	107	127
706	215	66	76	96
707	216	55	71	100
708	194	61	77	107
709	251		87	118

Data for number of transverse cracks were obtained from a photographic condition survey.

Table 12. Number of transverse cracks at Missouri project site.

Section Number	Prior to Overlay	13 Months After Overlay	24 Months After Overlay	35 Months After Overlay	51 Months After Overlay	63 Months After Overlay
701	0	0	0	0	2	0
702	1	55	3	6	61	21
703	0	12	11	13	29	11
704	9	112	15	29	129	43
705	0	282	6	8	69	15
706	6	86	98	98		102
707	3	80	95	95	105	101
708	2	74	76	81	81	94
709	4	125	117	117	148	130

Data for number of transverse cracks were obtained from a photographic condition survey.

than 12 months after construction of the PCC overlay. Additional data further into the service life of the PCC overlay are necessary to properly develop significant conclusions regarding the performance of the overlay at the Iowa site. Figure 1 shows the data from table 9 in graphical form.

The condition data collected for the Louisiana project site (except for section 709) follow typical trends in crack development following a structural overlay. The lack of a control section at the Louisiana site hinders a comparable evaluation of the performance of the PCC overlay. Only two post-overlay condition surveys are currently stored in the NIMS. Additional data further into the service life of the PCC overlay are necessary to properly develop significant conclusions regarding the performance of the overlay at the Louisiana site. Figure 2 shows the data in table 10 in graphical form.

The condition data collected for the Minnesota project site lack data from a manual condition survey completed prior to the overlay placement. The condition data collected after the construction of the overlay follow trends typical of transverse crack development in a structural overlay. Although the control section was not surveyed prior to the construction of the overlay, either manually or automatically, a significant number of transverse cracks (430 transverse cracks) were recorded in the survey 34 months after the overlay placement. This high number of transverse cracks in a 152-m (500-ft) section would indicate an average crack spacing of just over 0.3 m (1 ft). This frequency is significantly higher than the typical crack spacing in CRCP and may indicate additional distress-related problems that may affect the performance of the overlaid sections. Figures 3 and 4 show the data in table 11 in graphical form, with and without the photographic distress survey data.

The condition data collected for the Missouri project site lack data from a manual condition survey completed prior to the overlay placement. Although the construction report (ref. 1) states that a pre-overlay manual condition survey was performed for all of the Missouri project sections, no data are stored in the NIMS. There is a concern about the accuracy of the condition data collected for the sections at the Missouri site on the basis of an evaluation of the transverse cracking. Section 702 had a recorded 55 transverse cracks at 13 months after the overlay, 3 recorded transverse cracks after 24 months, and 61 transverse cracks after 51 months. Section 704 had a recorded 112 transverse cracks at 13 months after the overlay, 15 recorded transverse cracks after 24 months, and 129 transverse cracks after 51 months. Section 705 had a recorded 282 transverse cracks at 13 months after the overlay, 6 recorded transverse cracks after 24 months, and 69 transverse cracks after 51 months. There are no documented rehabilitations or repairs to the PCC overlay that would alter the number of transverse cracks from one year to the next. The same surveyor performed the condition survey for the 13-month and 24-month surveys. These fluctuations in transverse cracking data lead to concerns about the quality of all of the condition data stored in the NIMS for the Missouri site. Figures 5 and 6 show the data in table 12 in graphical form, with and without the photographic distress survey data.

Tables 13 to 15 present the percentage of transverse cracking occurring in the PCC overlay compared with the number of transverse cracks that existed in the original PCC slab. The number of transverse cracks prior to the overlay for the Minnesota site was obtained from

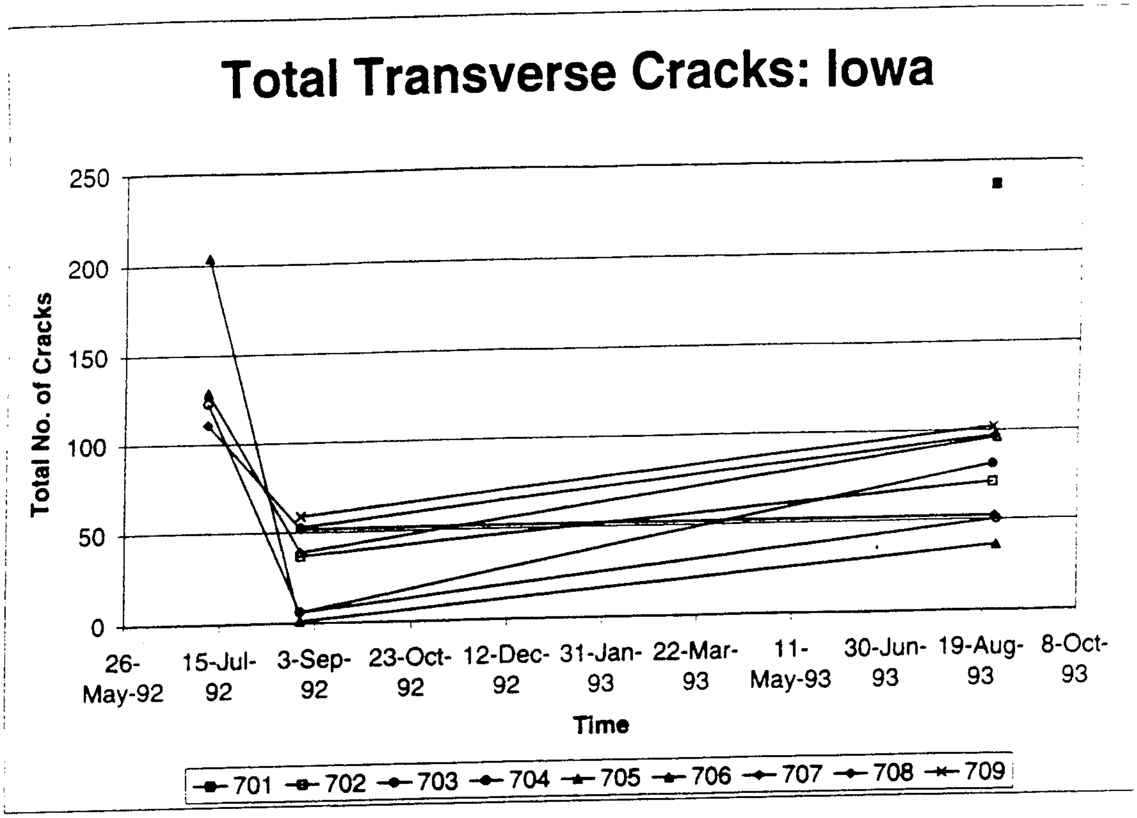

Figure 1. Total transverse cracks – Iowa.

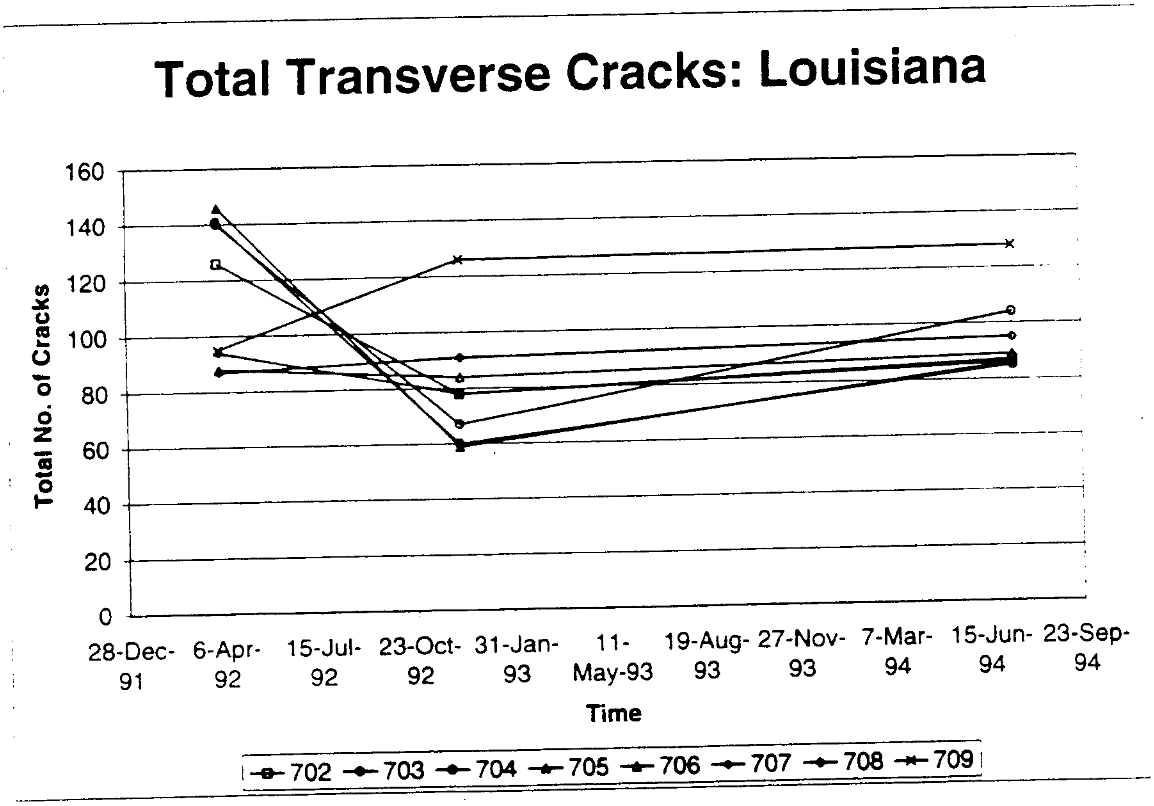

Figure 2. Total transverse cracks – Louisiana.

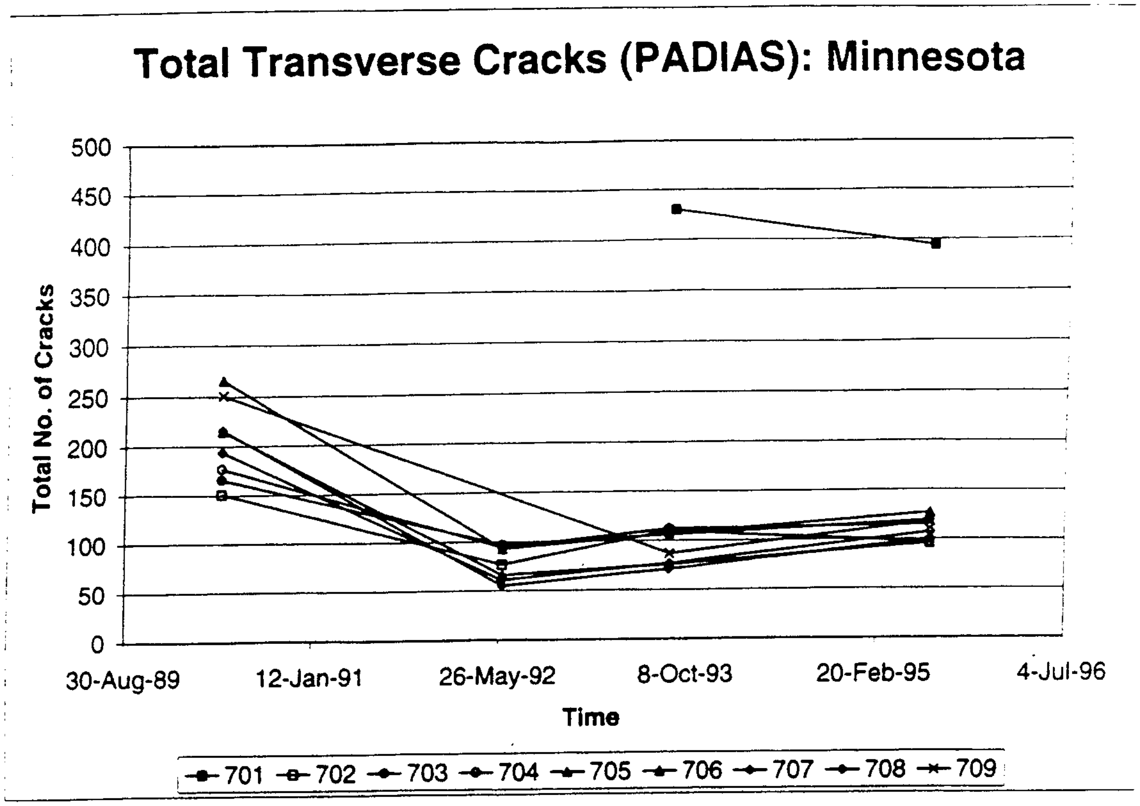

Figure 3. Total transverse cracks (PADIAS) – Minnesota.

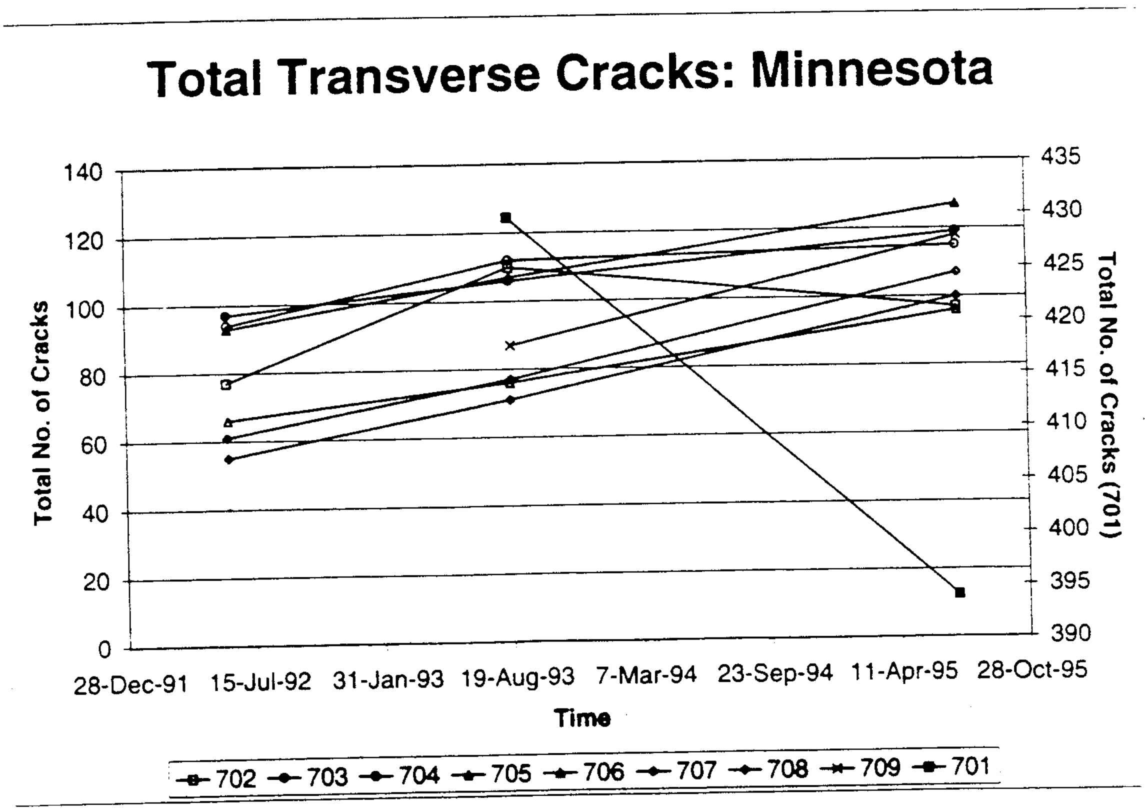

Figure 4. Total transverse cracks – Minnesota.

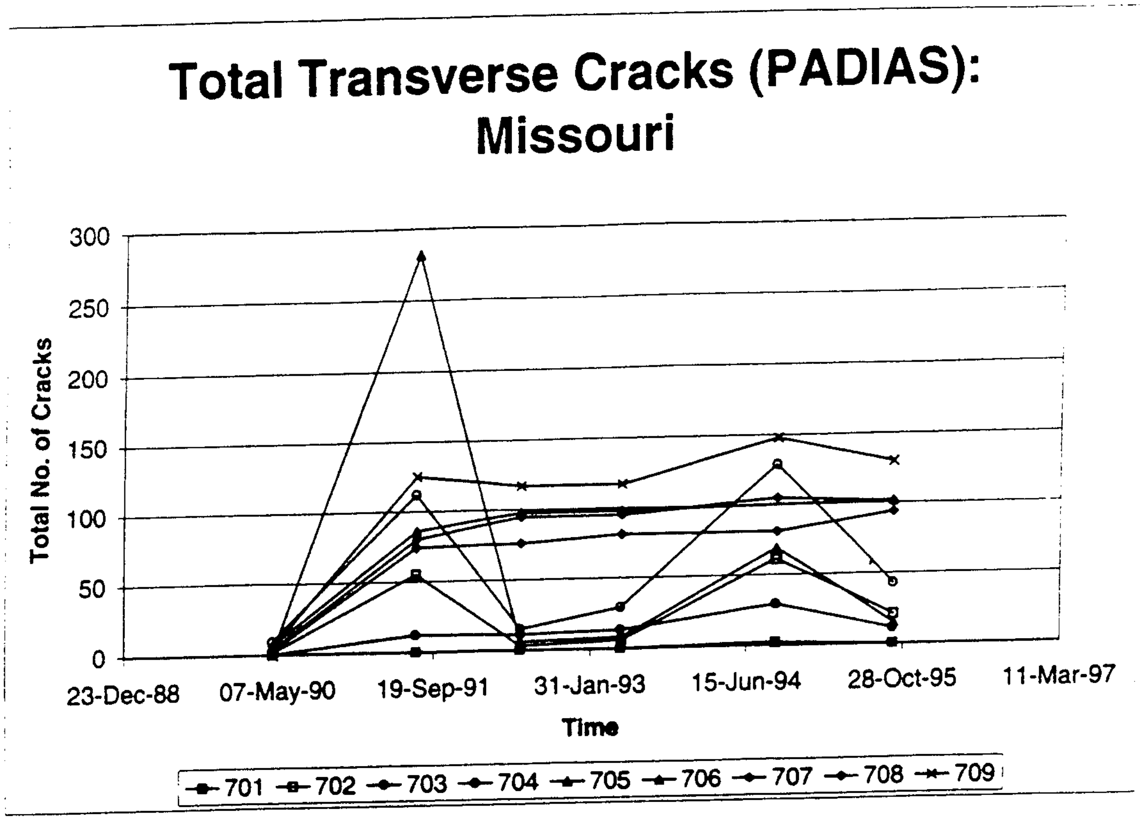

Figure 5. Total transverse cracks (PADIAS) – Missouri.

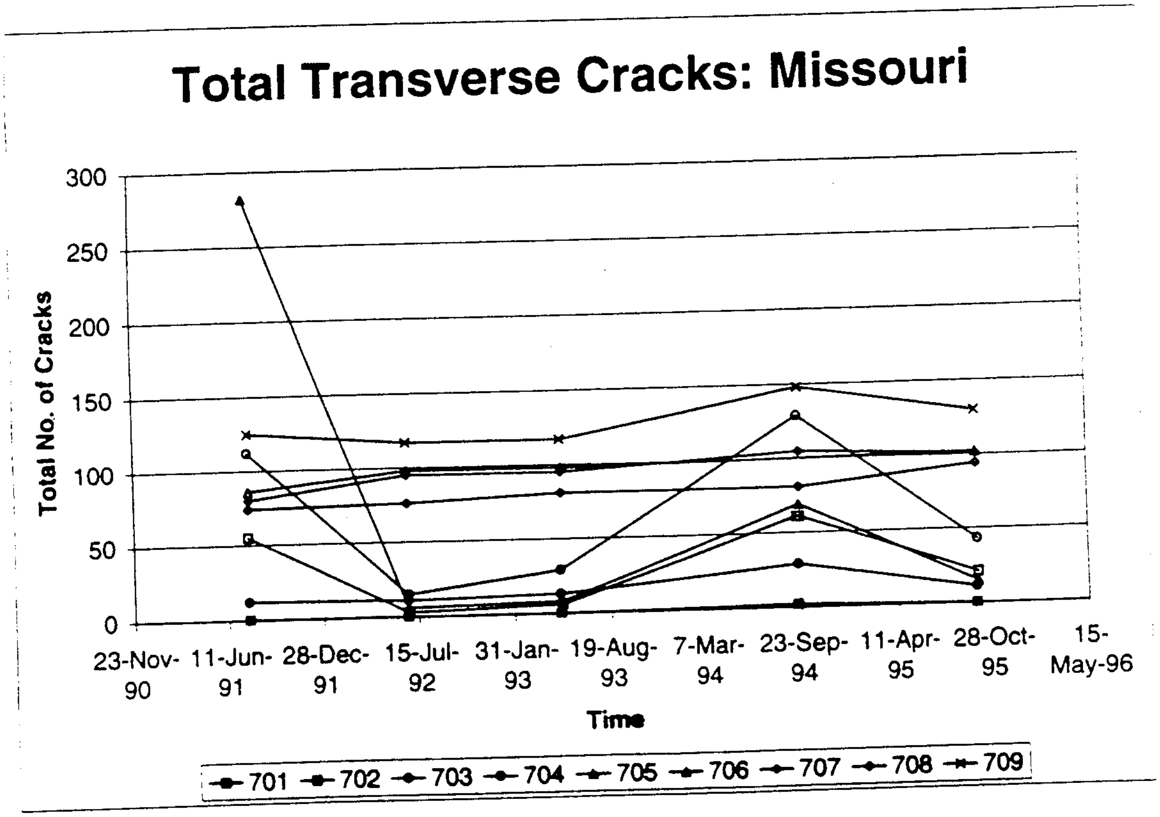

Figure 6. Total transverse cracks – Missouri.

Table 13. Percentage of transverse cracking after overlay construction at Iowa project site.

Section Number	Immediately After Overlay	12 Months After Overlay
701	---	---
702	---	---
703	---	---
704	5%	41%
705	0.5%	18%
706	30%	74%
707	47%	47%
708	---	---
709	---	---

Table 14. Percentage of transverse cracking after overlay construction at Louisiana project site.

Section Number	8 Months After Overlay	26 Months After Overlay
702	62%	69%
703	43%	60%
704	48%	74%
705	40%	59%
706	95%	101%
707	83%	91%
708	105%	109%
709	133%	135%

Table 15. Percentage of transverse cracking after overlay construction at Minnesota project site.

Section Number	20 Months After Overlay	34 Months After Overlay	57 Months After Overlay
701	---	---	---
702	51%	73%	64%
703	58%	63%	71%
704	53%	63%	64%
705	34%	40%	47%
706	31%	35%	45%
707	25%	33%	46%
708	31%	40%	55%
709	---	35%	47%

Note: Data for number of transverse cracks prior to overlay were obtained from the photographic condition survey.

the photographic distress survey and not the manual survey. The percentage of transverse cracking that reflected through the PCC overlay for the Missouri site is not presented. The numbers of transverse cracks after overlay for the Missouri site are sometimes 55 times greater than the number of cracks prior to the overlay, (1 transverse crack prior to the overlay and 55 transverse cracks after the overlay). As noted earlier, the high incidence of cracking in the overlay at the Missouri site is due to the extensive delaminations that have occurred at some of the test sections at that project site. Figures 7 to 9 show the data in tables 13 to 15 in graphical form.

Evaluating the percentage of transverse cracks in the PCC overlay compared with the transverse cracks in the original PCC slab allows for more comparable analysis of the performance of the different overlay features for CRCP projects. This type of comparison allows sections that began with a different number of transverse cracks in the original slab to be compared more fairly. A preliminary review indicates that the 76-mm (3-in) overlays are exhibiting a smaller percentage of transverse cracking after the overlay than the 127-mm (5-in) overlay for the project sites at Iowa and Louisiana. The 76-mm (3-in) overlays are exhibiting a greater percentage of transverse cracking after the overlay than the 127-mm (5-in) overlay for the project sites at Minnesota. These results indicate mixed performance of the 76- and 127-mm (3- and 5-in) overlays for the CRCP projects. The other experimental factors, use of grout and surface preparation, did not exhibit a clearly identifiable performance trend.

PCC Overlay Construction Data

The construction data in the NIMS and information in the construction reports are reasonably complete for the SPS-7 project sites, with the exception of the Minnesota site. There are no data in the NIMS concerning the preparation of the original PCC slab, the surface preparations, the construction of the overlay, or curing methods for the Minnesota site. The data for the other project sites, while not meeting the guidelines and specifications in some cases, appear reasonable.

Pre-overlay repairs were performed at all four SPS-7 project sites, and information on the repairs is available in the appropriate tables in the NIMS. Full-depth repairs were made at the sites in Iowa and Louisiana, and reflective crack repair was done at the site in Missouri. No information is available for pre-overlay repairs at the Minnesota site. Joint repairs were performed on some sections at the Iowa and Missouri project sites.

Several deviations from the construction guidelines were noted in the construction reports and noticed in the data from the NIMS. During construction of the PCC overlay at the Iowa site, the high temperatures for the day were quite high, in some cases up to 37°C (99°F). The thickness of the PCC overlay was greater than that specified in the experimental guidelines. A mistake was made in interpreting the string line at the time of construction, resulting in the thicker than specified overlays. There was a 7-day cure period for the overlay, which was covered with a cotton mat. The joints were sawed 12 to 24 hours after placement of the PCC overlay.

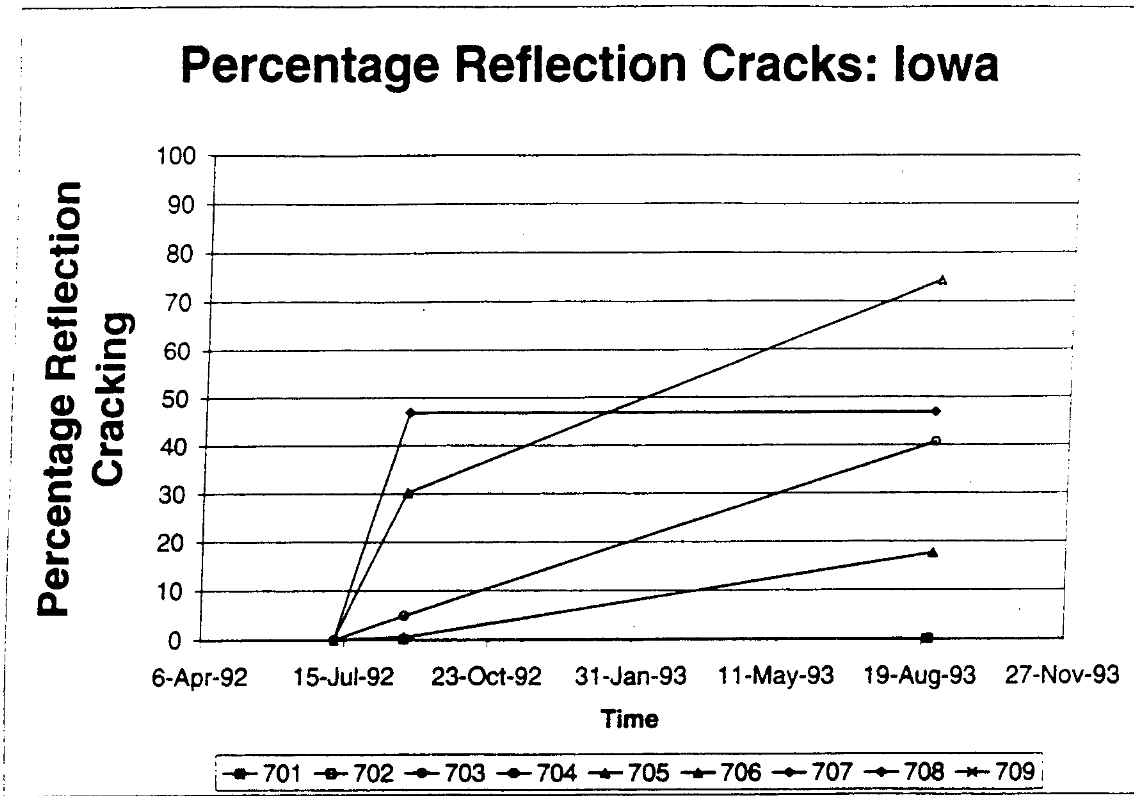

Figure 7. Percentage reflection cracks – Iowa.

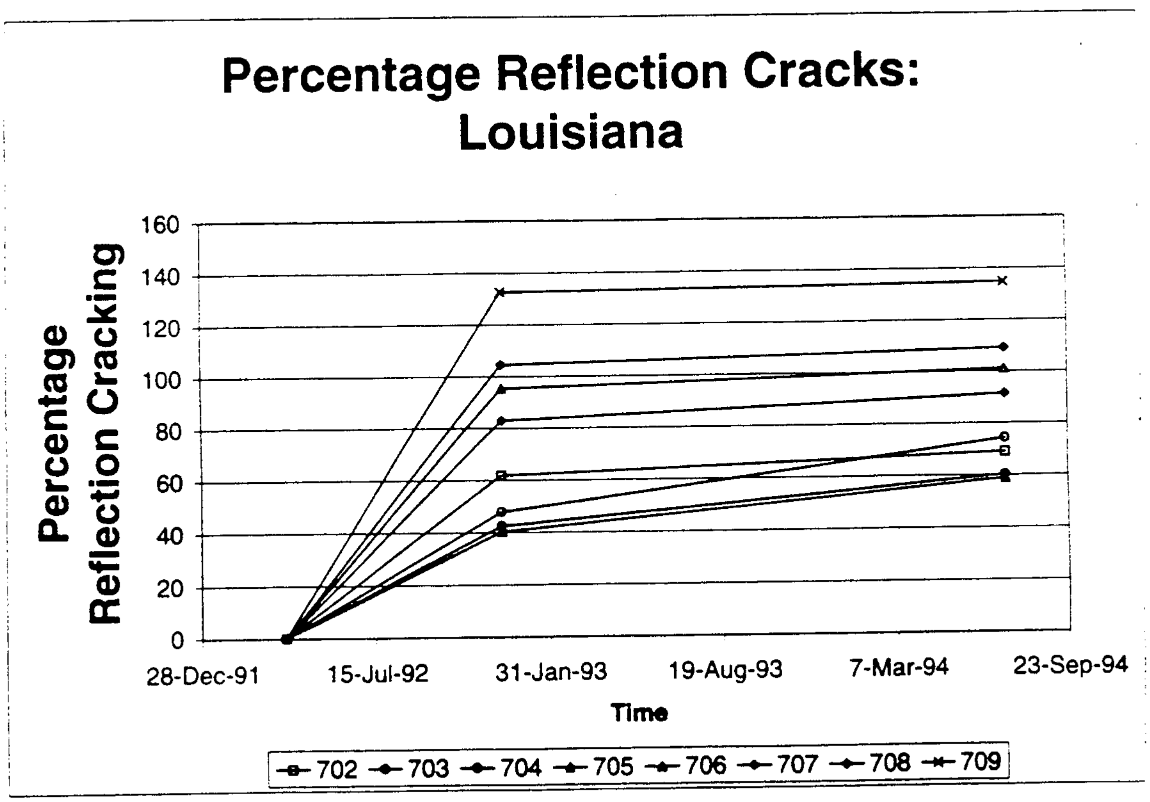

Figure 8. Percentage reflection cracks – Louisiana.

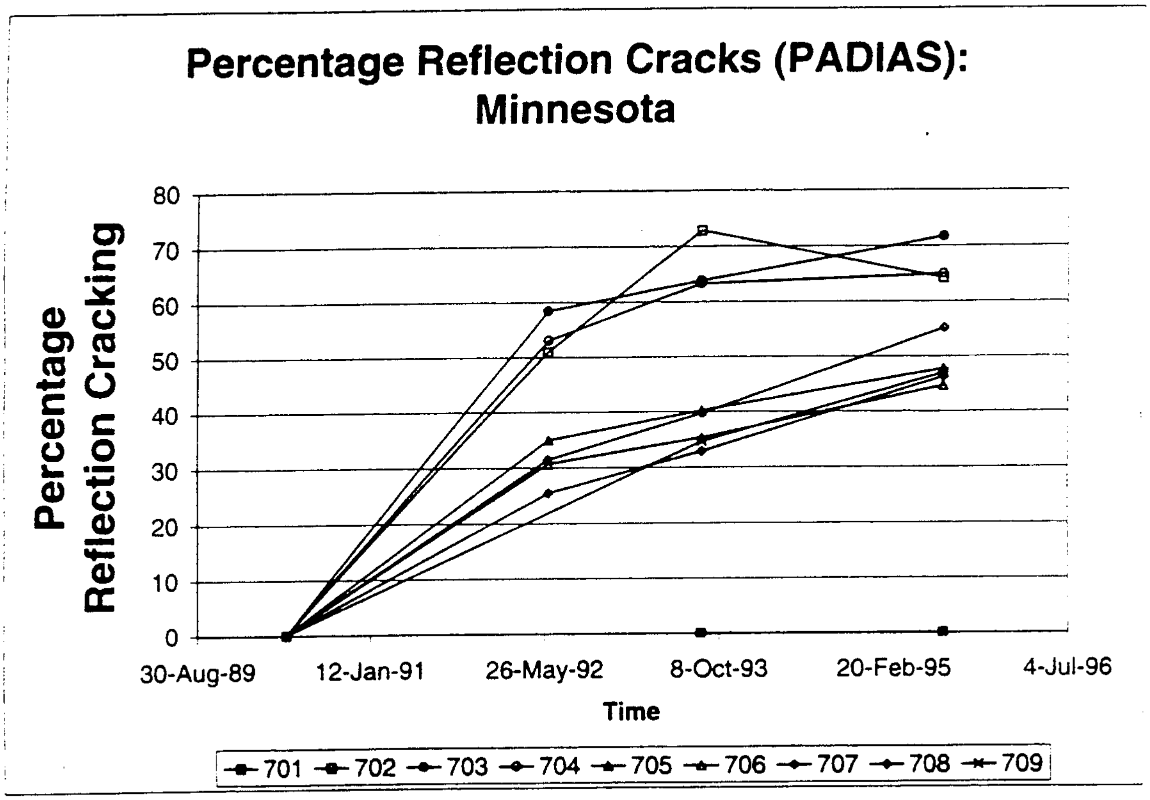

Figure 9. Percentage reflection cracks (PADIAS) - Minnesota.

The overlays constructed at the Louisiana project site were cured with a cotton mat for 14 days and sawed 8 hours after placement. Three important deviations from construction guidelines need to be noted for the Louisiana project site. An additional water-blast cleaning step was performed to further clean the previously milled 709 section. The timing of the water-blast produced a surface that was too wet in some locations, and paving operations had to be suspended. This pause in paving created a construction joint in section 709. Secondly, the grout that was placed 3 m (10 ft) in front of the paver on the specified sections was tracked over by the trucks delivering the concrete. Grout was then tracked over the cleaned original PCC surface and dried on the surface when the delivery trucks exited the project site. Efforts were made to remove the dried grout prior to placing the overlay in those locations. Lastly, the concrete overlay that was placed was greater in depth than the thickness specified in the construction specifications.

There were several deviations from construction guidelines for the sections constructed at the project site in Missouri. None of the sections except section 703 was blanketed within 4 hours of being placed, as specified in the construction guidelines; therefore, these sections were recorded as not having a curing method in the NIMS. Section 703 was covered with a cotton mat. The thickness of the overlays was slightly greater than the thickness specified in the construction guidelines.

There are no specific data available for the sections at the Minnesota project site regarding any construction deviations, other than an acknowledgment that no known deviations were noted during the construction of the PCC overlay.

All known deviations from construction guidelines or experimental design for all sites are presented in table 16.

PCC Overlay Thickness

The PCC overlay thickness in sections 702 to 705 was specified in the construction guidelines to be 76 mm (3 in); for sections 706 to 709, the thickness was specified to be 127 mm (5 in). The construction guidelines also specified that the final overlay thickness shall be within 6 mm (0.25 in) of the target value. Rod and level measurements were taken at five points across the width of the pavement at 30-m (100-ft) intervals before and after overlay placement to obtain the thickness of the PCC overlay. Cores taken from the sections were also measured for thickness. Therefore, thickness data for the PCC overlays are available from two sources, rod and level and core measurements. No data were available from the rod and level measurement for the Minnesota site because no rod and level survey was performed. The average overlay thickness results of rod and level measurement from the sections are presented in table 17. The data in table 17 are from a total of 25 measurements for each section.

The overlay thickness results from core measurements are presented in table 18. The data in table 18 are from a SPS-7 specific table in the NIMS. Core measurements were not available for the projects at Iowa or Minnesota in the SPS-7 specified table in the NIMS. Overlay

Table 16. Known construction deviations.

State	Section	Known Deviations
Iowa	702	Overlay thickness greater than specifications.
	703	Overlay thickness greater than specifications.
	704	Overlay thickness greater than specifications.
	705	Overlay thickness greater than specifications.
	706	Overlay thickness greater than specifications.
	707	Overlay thickness greater than specifications.
	708	Overlay thickness greater than specifications.
	709	Overlay thickness greater than specifications.
Louisiana	702	Overlay thickness greater than specifications. Grout tended to dry prior to PCC placement.
	703	Overlay thickness greater than specifications.
	704	Overlay thickness greater than specifications.
	705	Overlay thickness greater than specifications. Grout tended to dry prior to PCC placement.
	706	Overlay thickness greater than specifications. Grout tended to dry prior to PCC placement.
	707	Overlay thickness greater than specifications.
	708	Overlay thickness greater than specifications.
	709	Overlay thickness greater than specifications. Grout tended to dry prior to PCC placement. Additional water-blast cleaning caused damp conditions, suspending paving operations and creating a construction joint.
Minnesota	702	No known deviations or deviations noted.
	703	No known deviations or deviations noted.
	704	No known deviations or deviations noted.
	705	No known deviations or deviations noted.
	706	No known deviations or deviations noted.
	707	No known deviations or deviations noted.
	708	No known deviations or deviations noted.
	709	No known deviations or deviations noted.
Missouri	702	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	703	Overlay thickness greater than specifications. Incorrect dowel bars used for pre-overlay full-depth repairs.
	704	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	705	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	706	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	707	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	708	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).
	709	Overlay thickness greater than specifications. Fresh concrete was not cured properly with covering (cotton mat).

Table 17. PCC overlay thicknesses in mm from rod and level measurements.

State	Section	Target Thickness	Average Thickness	Standard Deviation of Thickness	Minimum Thickness	Maximum Thickness
Iowa	702	76.2 +/- 6.3	99.1	12.7	71.1	124.5
	703	76.2 +/- 6.3	99.1	11.9	66.0	121.9
	704	76.2 +/- 6.3	119.4	10.9	86.4	147.3
	705	76.2 +/- 6.3	111.8	13.7	86.4	139.7
	706	127.0 +/- 6.3	165.1	12.4	134.6	188.0
	707	127.0 +/- 6.3	165.1	8.4	149.9	182.9
	708	127.0 +/- 6.3	144.8	12.2	121.9	175.3
	709	127.0 +/- 6.3	134.6	9.9	109.2	160.0
Louisiana	702	76.2 +/- 6.3	88.9	6.6	76.2	106.7
	703	76.2 +/- 6.3	86.4	7.6	73.7	104.1
	704	76.2 +/- 6.3	91.4	6.6	76.2	101.6
	705	76.2 +/- 6.3	94.0	8.6	78.7	111.8
	706	127.0 +/- 6.3	144.8	6.1	132.1	157.5
	707	127.0 +/- 6.3	144.8	7.1	134.6	157.5
	708	127.0 +/- 6.3	149.9	4.8	137.2	157.5
	709	127.0 +/- 6.3	137.2	5.3	124.5	149.9
Minnesota	No data available					
Missouri	702	76.2 +/- 6.3	91.4	11.4	73.7	116.8
	703	76.2 +/- 6.3	88.9	11.4	73.7	116.8
	704	76.2 +/- 6.3	83.8	15.0	55.9	111.8
	705	76.2 +/- 6.3	78.7	6.6	66.0	96.5
	706	127.0 +/- 6.3	132.1	10.9	111.8	149.9
	707	127.0 +/- 6.3	132.1	9.7	116.8	152.4
	708	127.0 +/- 6.3	134.6	7.9	121.9	149.9
	709	127.0 +/- 6.3	134.6	5.3	127.0	152.4

Table 18. PCC overlay thicknesses in mm from core measurements.

State	Section	Target Thickness	Avg. Thickness	Standard Deviation of Thickness	Minimum Thickness	Maximum Thickness
Iowa	No data available					
Louisiana	702	76.2 +/- 6.3	88.9	10.2	76.2	101.6
	703	76.2 +/- 6.3	86.4	7.6	73.7	101.6
	704	76.2 +/- 6.3	91.4	7.6	78.7	101.6
	705	76.2 +/- 6.3	94.0	7.6	78.7	101.6
	706	127.0 +/- 6.3	144.8	5.1	132.1	152.4
	707	127.0 +/- 6.3	144.8	7.6	134.6	152.4
	708	127.0 +/- 6.3	149.9	5.1	137.2	152.4
	709	127.0 +/- 6.3	137.2	5.1	124.5	152.4
Minnesota	No data available					
Missouri	702	76.2 +/- 6.3	111.8	12.7	91.4	127.0
	703	76.2 +/- 6.3	76.2	10.2	63.5	76.2
	704	76.2 +/- 6.3	91.4	0.0	81.3	101.6
	705	76.2 +/- 6.3	76.2	2.5	73.7	76.2
	706	127.0 +/- 6.3	121.9	10.2	111.8	127.0
	707	127.0 +/- 6.3	124.5	7.6	114.3	127.0
	708	127.0 +/- 6.3	132.1	10.2	116.8	152.4
	709	127.0 +/- 6.3	137.2	7.6	129.5	152.4

thicknesses for all of the sections at the SPS-7 project sites were stored in the testing table in the NIMS, TST_LO5B. The core results from table TST_LO5B are presented in table 19.

In both types of thickness measurements, the majority of the sections had average overlay thickness greater than the specified thickness. The average overlay thicknesses of the sections at the Iowa site are typically 25.4 mm (1 in) greater than the target value. In some cases, the overlay thicknesses of the sections at the Iowa site are as great as 38 mm (1.5 in) thicker than the target value. The average overlay thickness of the sections at the Louisiana site ranged from 13 to 25 mm (0.5 to 1 in) greater than the target thickness values. Although no rod and level measurements were performed and core data were not available in the NIMS, data in table TST_LO5B indicated the overlay thickness values at the Minnesota site ranged from about 10 mm (0.4 in) less to 13 mm (0.5 in) more than the target value. The average overlay thickness of the sections at the Missouri site ranged from 13 mm (0.5 in) less to 13 mm (0.5 in) more than the target thickness values.

The thickness values stored in table TST_LO5B for the Missouri site are less than the thickness values stored in the SPS-7 specific tables for core measurements and rod and level measurements for sections 706 to 709. Analyzing only the data from the TST_LO5B table, there is no distinction in overlay thickness between the test sections at the Missouri site. In the TST_LO5B table, all the sections have an overlay thickness that ranges from 76 to 102 mm (3 to 4 in), with one exception. This discrepancy indicates a difference in overlay thickness between the core and rod and level measurement locations, or inaccurate measurements. Since the rod and level measurements and the core measurements stored in the SPS-7 specific table are similar, it is likely the thickness data stored in the TST_LO5B table are not accurate.

Additional core data are stored in the material testing category of tables in the NIMS. Table TST_PC06 is for core examination and thickness information. The information in this table is similar to the data found in table TST_LO5B, with the exception that overlay thickness data for the Minnesota and Missouri project sites were not available in this table. In addition to the lack of data from the Minnesota site from table TST_PC06, only the thickness data for the layers beneath the PCC overlay were available; no overlay thickness was available. The data stored in the TST_PC06 table are summarized in table 20.

Material Testing Data

The properties and characteristics of the materials in the pavement structure are critical to the performance and service life of the entire pavement system. Data regarding material properties and characteristics for SPS-7 project sites are stored in the NIMS under several different tables. The following is a listing of all of the appropriate tables and their naming extension:

- T07 - Aggregate Gradation.
- T08 - Hydrometric Analysis of Aggregate.
- T09 - PCC Compressive Strength.
- T11 - Splitting Tensile.

Table 19. Overlay thickness in mm from TST_LO5B table.

Section	Target Thickness	Iowa	Louisiana	Minnesota	Missouri
702	76.2 +/- 6.3	94.0	91.4	94.0	101.6
703	76.2 +/- 6.3	111.8	94.0	86.4	91.4
704	76.2 +/- 6.3	104.1	91.4	81.3	91.4
705	76.2 +/- 6.3	109.2	99.1	81.3	88.9
706	127.0 +/- 6.3	162.6	149.9	127.0	142.2
707	127.0 +/- 6.3	157.5	147.3	124.5	96.5
708	127.0 +/- 6.3	134.6	147.3	142.2	104.1
709	127.0 +/- 6.3	137.2	137.2	116.8	109.2

Table 20. Overlay thickness in mm from cores.

State	Section	Target Thickness	No. of Cores	Avg. Thickness	Standard Deviation of Thickness	Min. Thickness	Max. Thickness
Iowa	702	76.2 +/- 6.3	---	---	---	---	---
	703	76.2 +/- 6.3	8	111.4	9.4	101.6	121.9
	704	76.2 +/- 6.3	8	105.1	12.5	88.9	116.8
	705	76.2 +/- 6.3	8	112.1	5.0	104.1	116.8
	706	127.0 +/- 6.3	17	164.1	5.6	154.9	172.7
	707	127.0 +/- 6.3	17	156.9	5.6	144.8	165.1
	708	127.0 +/- 6.3	17	135.2	2.5	129.5	139.7
	709	127.0 +/- 6.3	14	139.7	14.4	101.6	172.7
Louisiana	702	76.2 +/- 6.3	8	92.9	5.5	86.4	104.1
	703	76.2 +/- 6.3	9	95.1	12.0	86.4	119.4
	704	76.2 +/- 6.3	8	93.8	6.0	86.4	101.6
	705	76.2 +/- 6.3	8	100.9	3.8	96.5	107.2
	706	127.0 +/- 6.3	17	150.8	14.6	132.1	167.6
	707	127.0 +/- 6.3	17	147.3	3.2	142.0	152.4
	708	127.0 +/- 6.3	16	147.2	14.0	139.7	198.1
	709	127.0 +/- 6.3	16	134.9	8.11	121.9	147.3
Minnesota	No data available.						
Missouri	Data available for lower pavement layers only, no PCC overlay thickness data.						

Source: Table TST_PC06

- T12 - PCC Static Modulus.
- T13 - Aggregate Type and Class.
- T15 - Atterberg Limits.
- T16 - Moisture/Density of Base/Subbase.
- T17 - Natural Moisture of Base/Subbase.
- T18 - Test Hole Location.
- T19 - Test Hole Information.
- T20 - In-situ Density and Moisture.
- T22 - Core Exam and Thickness.
- T24 - Unbound Granular.
- T26 - Summary of Resilient Modulus.
- T31 - LO5A (Layer Data).
- T32 - LO5B (Layer Data).
- T33 - Lab Testing Data (Project Level).
- T51 - Fresh PCC Sampling .
- T52 - Lab Disposal of AC.
- T53 - Lab Disposal for PCC.
- T54 - Density of PCC.
- T55 - PCC Shear Strength.
- T57 - Flexural Strength (Rupture).
- T73 - Density of Subgrade.
- T76 - Permeability of Base/Subbase.

There is a large amount of missing information for material testing data presently in the NIMS for SPS-7 project sites. All of the material testing tables listed above are populated with some "sporadic" information, but none are complete and sufficient. Table 21 is a matrix identifying the sections that have data stored in the NIMS for the SPS-7 project sites.

The data in the material testing tables in the NIMS are reasonable in terms of ranges of values for the overlay PCC material properties. Table 22 contains the modulus of rupture, elastic modulus, tensile strength, and compressive strength populated in the NIMS for the four SPS-7 project sites. The extent of missing data across material testing types and sections can be seen clearly in table 22.

PCC Bond Strength Data

The bond strength between the PCC overlay and the original PCC slab is a critical element in the performance of bonded concrete overlays. Data gathered from laboratory testing of cores for bond strength provide an indication of the bond that exists in the field between the overlay and the original slab. Laboratory bond strength data were available for all SPS-7 project sites except Minnesota. The data populated in the NIMS for bond strength were reasonable, with the exception of a few outlier data points. Statistics for the data available for bond strength are presented in table 23.

Table 21. Sections with material testing data.

Test	Iowa	Louisiana	Minnesota	Missouri
T07 - Agg. Grad.	702, 705, 708	702, 705, 707		701, 709
T08 - Hydro Analysis of Agg.	702, 705, 708	702, 705, 707		701, 709
T09 - PCC Comp. Strength	All sections	All sections		All sections
T11 - Split Tensile	All sections	All sections		706, 707
T12 - PCC Static Modulus		702, 705, 706, 707, 708, 709		706, 707, 708
T13 - Agg. Type & Class	702, 705, 708	702, 705, 707		701, 709
T15 - Att. Limits	702, 705, 708	702, 705, 707		701, 709
T16 - Moist/Dens. of Base/Subbase	702, 705, 708	702, 705, 707		701, 709
T17 - Natural Moist. of Base/Subbase	702, 705, 708	702, 705, 707		701, 709
T18 - Test Hole Location	All sections	All sections	All sections	All sections
T19 - Test Hole Information	All sections	All sections	All sections	All sections
T20 - In-situ Density & Moisture	702, 705, 707	702, 708		
T22 - Core Exam & Thickness	All sections except 702	All sections		
T24 - Unbound Granular		702, 704		
T26 - Summary of Resilient Modulus		702, 704		
T31 - L05A (Layer Data)	All sections	All sections	All sections	All sections
T32 - L05B (Layer Data)	All sections	All sections	All sections	All sections
T33 - Lab Testing Data (Project level)	All sections	All sections	All sections	All sections
T51 - Fresh PCC Sampling	702	702, 703, 705, 706, 708, 709		All sections

Table 21. Sections with material testing data (continued).

Test	Iowa	Louisiana	Minnesota	Missouri
T54 - Density of PCC	All sections	All sections		706, 707, 708
T55 - PCC Shear Strength	All sections	All sections		All sections
T57 - Flexural Strength		702, 703, 705, 706, 708, 709		All sections
T73 - Density of Subgrade	704, 705, 707, 708	702, 704		
T76 - Permeability of Base/Subbase	702, 705, 707			

Table 22. PCC overlay material properties.

State	Section Number	Average Flexural Strength, kPa	Average Elastic Modulus, kPa	Average Splitting Tensile Strength, kPa	Average Compressive Strength, kPa
Iowa	702	---	---	4,068	43,714
	703	---	---	3,999	45,438
	704	---	---	4,413	46,265
	705	---	---	4,068	42,542
	706	---	---	3,465	36,923
	707	---	---	3,327	43025
	708	---	---	4,637	43,826
	709	---	---	4,298	44,243
Louisiana	702	5,171	41,025,250	4,298	49,920
	703	5,602	---	4,176	51,092
	704	---	---	4,564	59,607
	705	5,584	39,067,070	3,946	44,110
	706	4,933	42,086,342	4,392	50,080
	707	---	45,003,665	4,542	45,401
	708	5,033	40,932,578	4,659	49,514
	709	5,361	40,414,760	4,101	46,318
Minnesota	No data available				
Missouri	702	3,778	---	---	28,145
	703	4,597	---	---	35,187
	704	3,833	---	---	29,959
	705	3,804	---	---	31,827
	706	3,730	33,557,965	---	30,918
	707	4,185	33,247,690	4,720	31,181
	708	3,755	31,365,355	4,421	29,156
	709	3,995	---	---	30,815

Table 23. Bond strength statistics.

State	Section Number	No. of Tests	Bond Age, month	Average Bond Strength, kPa	Bond Strength Std. Dev., kPa	Minimum Bond Strength, kPa	Maximum Bond Strength, kPa
Iowa	702	2	12	4,137	878	3,516	4,757
	703	3	1	2,942	340	2,551	3,172
	703	3	12	3,309	847	2,344	3,930
	704	4	1	3,647	476	3,316	4,337
	704	4	12	2, 706	1,245	1,792	4,551
	705	4	1	2,840	879	2,034	3,799
	705	4	12	4,913	1,778	2,758	6,826
	706	4	1	2,684	995	1,972	4,158
	706	4	12	3,758	1,236	2,413	5,378
	707	4	1	3,146	1,001	2,510	4,627
	707	3	12	4,298	1,498	2,689	5,654
	708	2	1	2,724	439	2,413	3,034
	708	4	12	5,361	1,944	2,758	7,240
	709	3	1	3,562	1,513	2,689	5,309
	709	3	12	3,907	1,032	2,758	4,758
Louisiana	702	3	1	2,815	678	2,193	3,537
	702	3	14	5,256	1,454	4,144	6,902
	703	4	1	2,263	316	1,841	2,558
	703	4	14	8,686	3,816	5,578	14,017
	704	4	1	2,425	292	2,117	2,799
	704	4	14	8,145	1,336	6,716	9,625
	705	4	1	2,601	803	1,772	3,378
	705	4	14	8,222	3,274	4,895	11,576
	706	1	1	2,082	N/A	2,082	2,082
	706	4	14	7,910	1,216	6,785	9,453
	707	1	1	2,089	N/A	2,089	2,089
	708	1	1	2,193	N/A	2,192	2,192
	708	2	14	6,209	541	5,826	6,591
	709	3	1	2,202	373	1,820	2,564
	709	4	14	6,228	3,320	2,234	9,681

Table 23. Bond strength statistics (continued).

State	Section Number	No. of Tests	Bond Age, month	Average Bond Strength, kPa	Bond Strength Std. Dev., kPa	Minimum Bond Strength, kPa	Maximum Bond Strength, kPa
Minnesota	No data available.						
Missouri	702	6	1	2,433	417	1,786	2,923
	702	3	13	2,666	469	2,137	3,033
	703	6	1	3,758	924	2,482	4,964
	703	4	13	3,482	567	2,758	4,137
	704	4	13	3,361	375	2,964	3,861
	705	5	1	1,755	906	641	2,647
	705	4	13	2,999	547	2,551	3,792
	706	4	1	1,775	995	400	2,592
	707	5	1	2,925	1,074	1,744	4,633
	708	6	1	2,429	936	627	3,054
	708	4	13	3,085	778	2,344	3,792
	709	6	1	2,737	723	1,841	3,654
	709	4	13	3,930	844	2,965	4,827

Note: Bond testing conducted in accordance with SHRP Protocol P67.

The bond strength values stored in the NIMS for the Iowa and Missouri SPS-7 sites are reasonable, with no missing data. The bond strength values for the Louisiana site are unreasonably high for the test at 14 months. Sections 703, 704, 705, and 706 for the Louisiana site all have average bond strength values exceeding 6895 kPa (1000 psi), with a maximum single test exceeding 13790 kPa (2000 psi).

Delamination Survey Data

Delamination surveys of bonded concrete overlays provide an overall evaluation of the bond characteristics of the pavement structure, versus a point-specific test obtained from core testing. A delamination survey can be completed with an automated survey (radar) or manual survey (chain drag/hammer). The delamination survey offers a mechanism to interpret the bonding performance of the PCC overlay for the entire pavement surface.

Only the Iowa and Missouri project sites had data based on delamination surveys. The delamination surveys were done manually using the chain drag/hammer technique. The construction record report for the Louisiana site stated that no delamination survey data were completed because of insufficient guidance to perform the test. The Minnesota site has no record of data collected and no mention that any delamination survey data were ever collected in the construction reports. The Iowa site has one manual delamination survey data-populated in the NIMS, but some of the data appear to be questionable. Delamination areas were populated in the database for the control section (without an overlay) and for sections prior to the PCC overlay for the Iowa site. The delamination survey dates were recorded after the PCC overlay construction, but the CONSTRUCTION_NO field indicated that the overlay was not placed at that time for the Iowa site. Therefore, only the Missouri site appears to have useful data available for future analysis. Figures 10 to 17 show the total area delaminated and the number of slabs delaminated versus time for the Missouri site. It should be noted that the delaminations at the Missouri test sections developed soon after construction and have remained fairly stable since then. The delamination data available for the Iowa project site are presented in table 24.

Profile Data

It is known that profile measurements have been made at regular intervals at all SPS-7 project sites. However, no profile data (e.g., IRI) are currently available in the NIMS.

Traffic Data

Accurate traffic information is an important element in pavement performance and future service life analyses. The Iowa and Minnesota projects had weigh-in-motion (WIM) systems installed at the time of construction. Currently, of the four SPS-7 project sites, only Minnesota has traffic data populated in the appropriate tables in the NIMS. However, discussions with the LTPP North Central Regional contractor indicated that no WIM traffic data were available in their regional database. Traffic data for the Minnesota site are available from 1970 to 1992 in the NIMS. Both the Iowa and Missouri sites had traffic data estimates presented in their

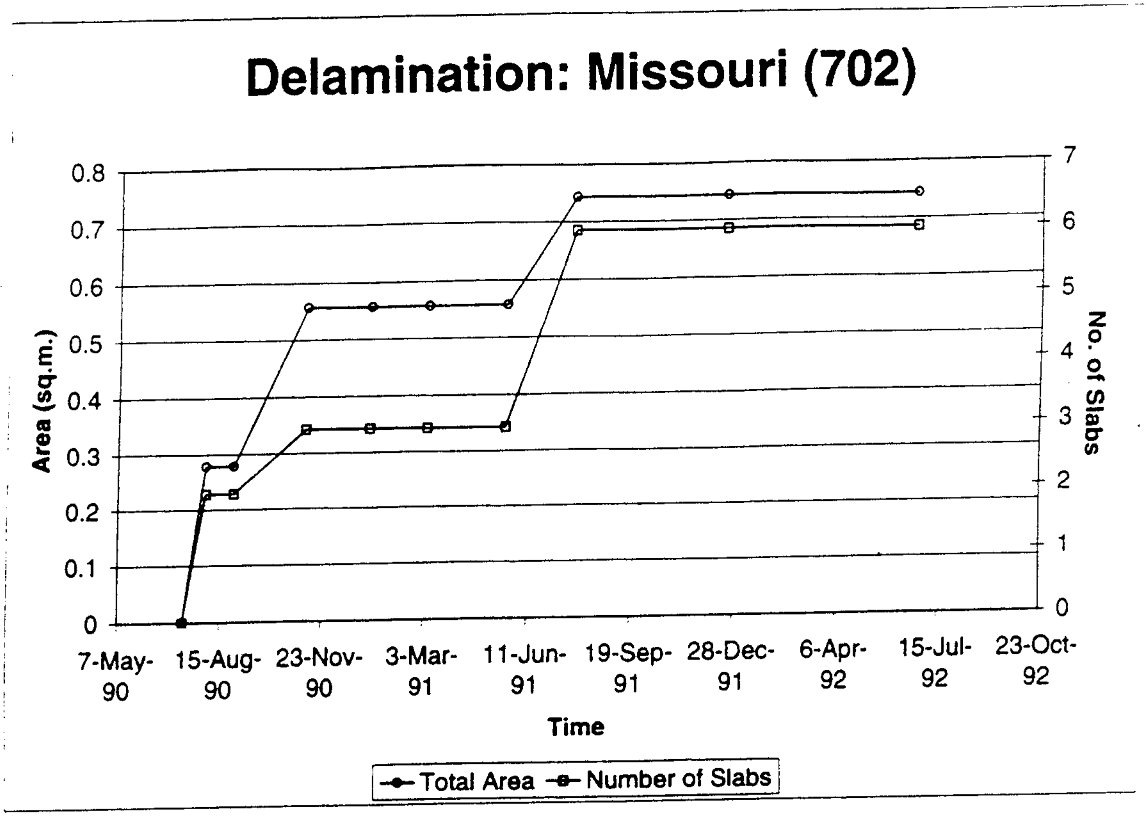

Figure 10. Delamination – Missouri (702).

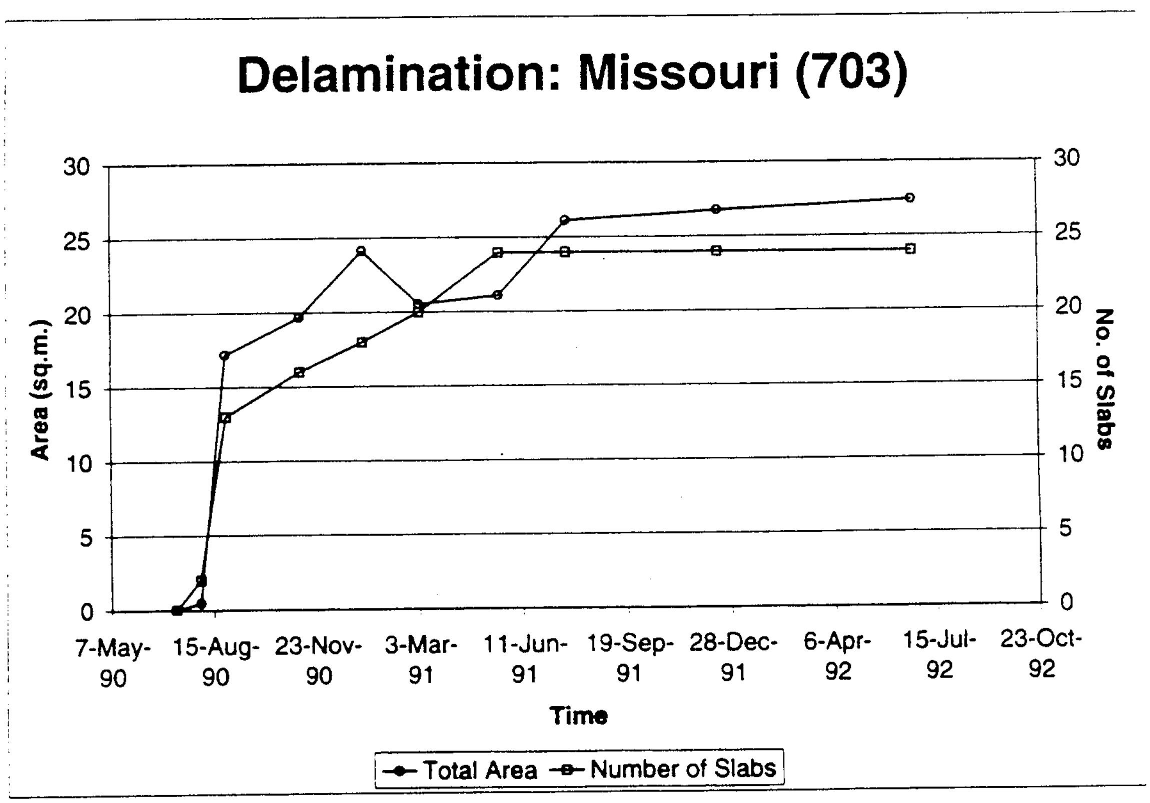

Figure 11. Delamination – Missouri (703).

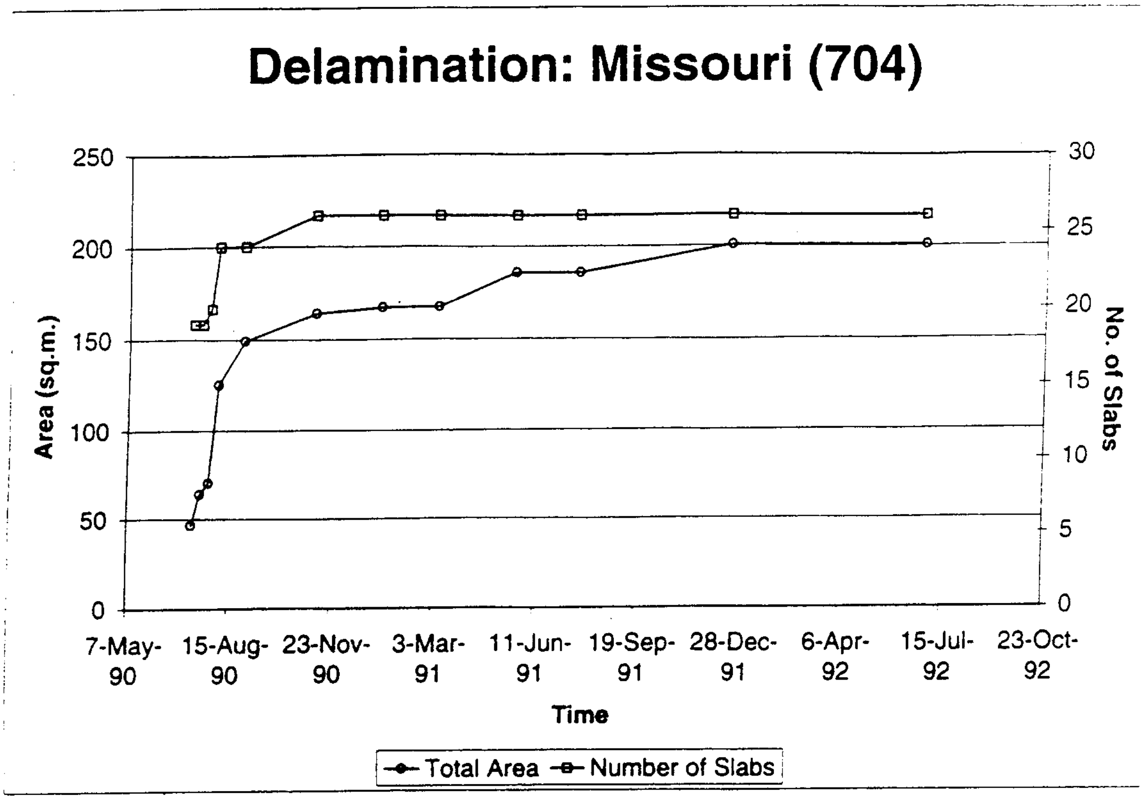

Figure 12. Delamination – Missouri (704).

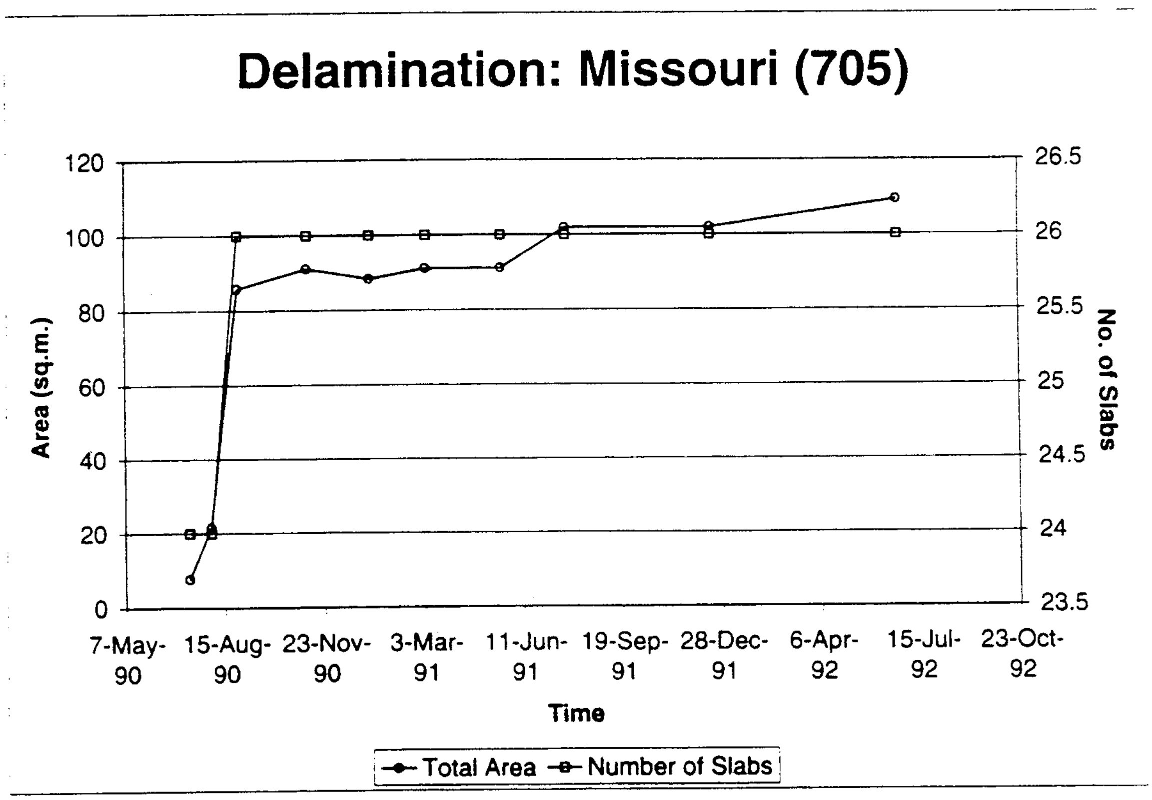

Figure 13. Delamination – Missouri (705).

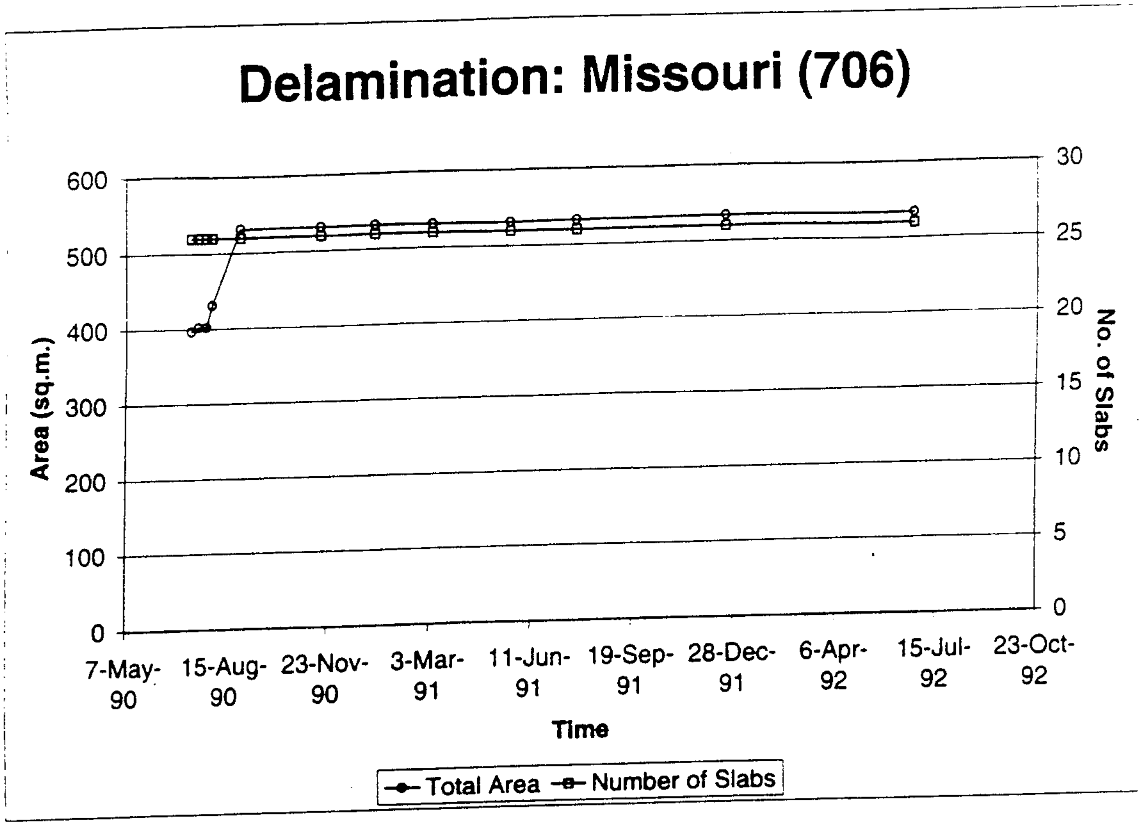

Figure 14. Delamination – Missouri (706).

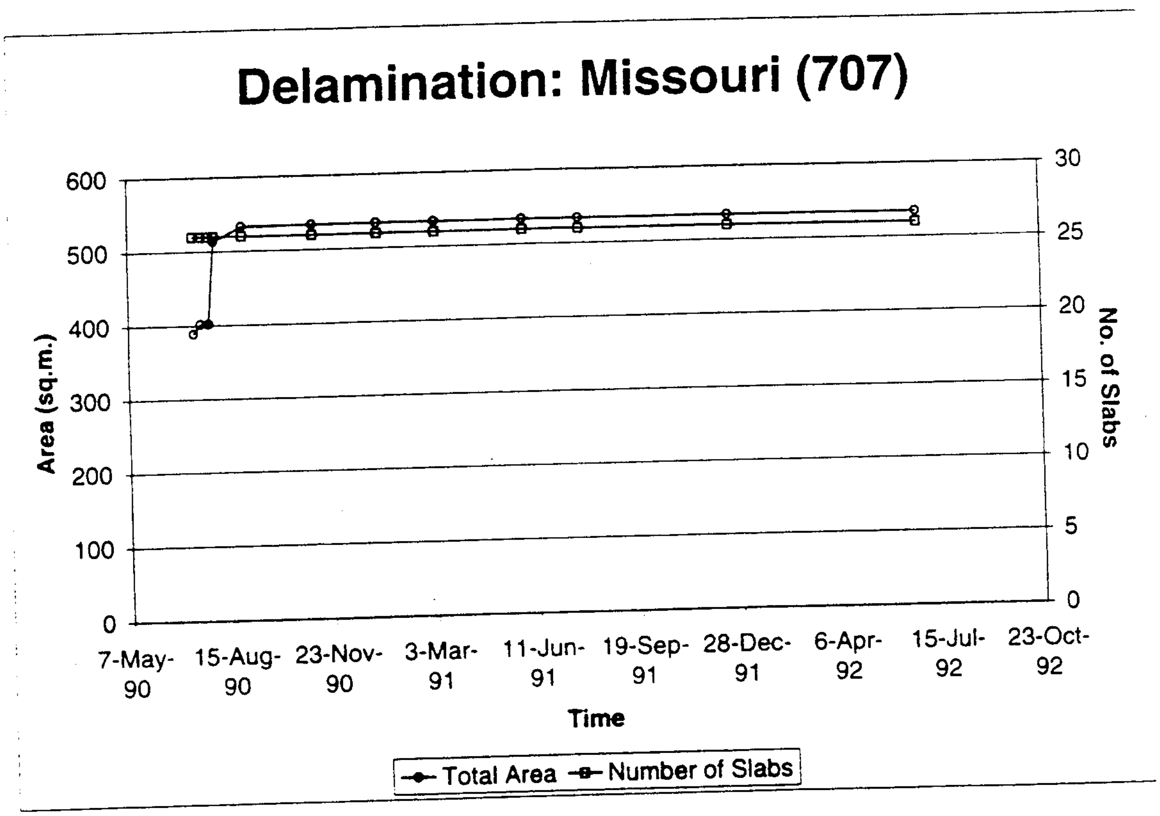

Figure 15. Delamination – Missouri (707).

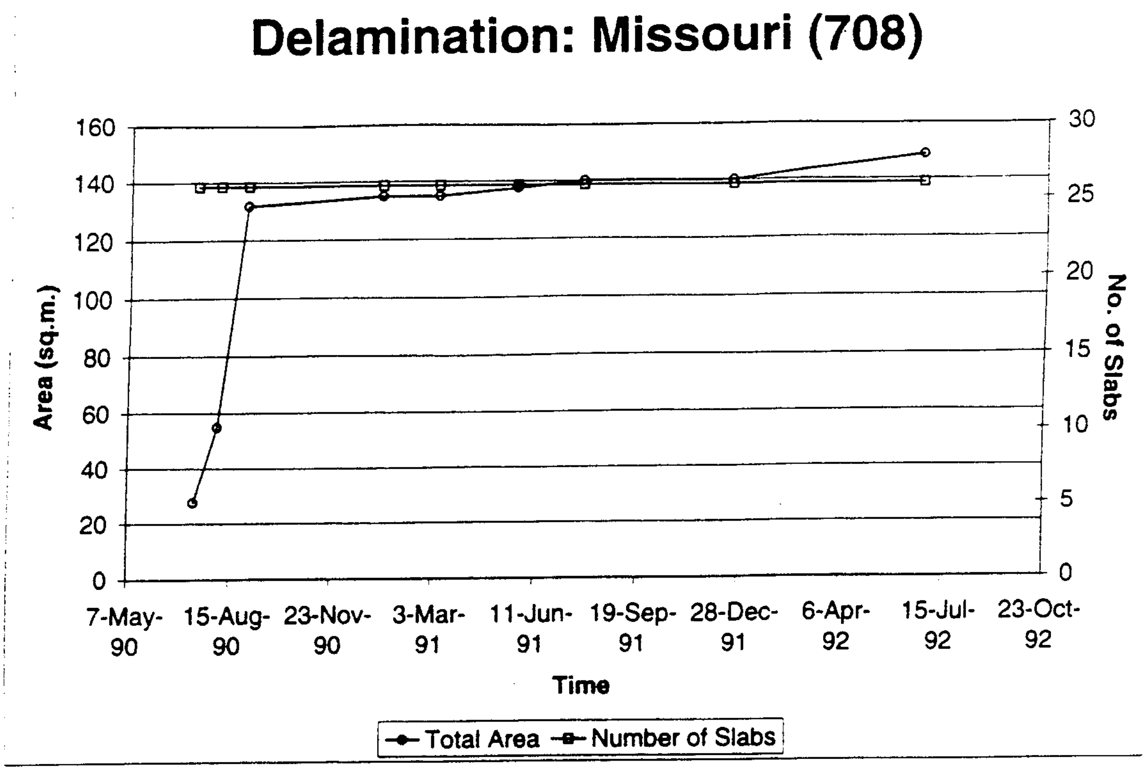

Figure 16. Delamination – Missouri (708).

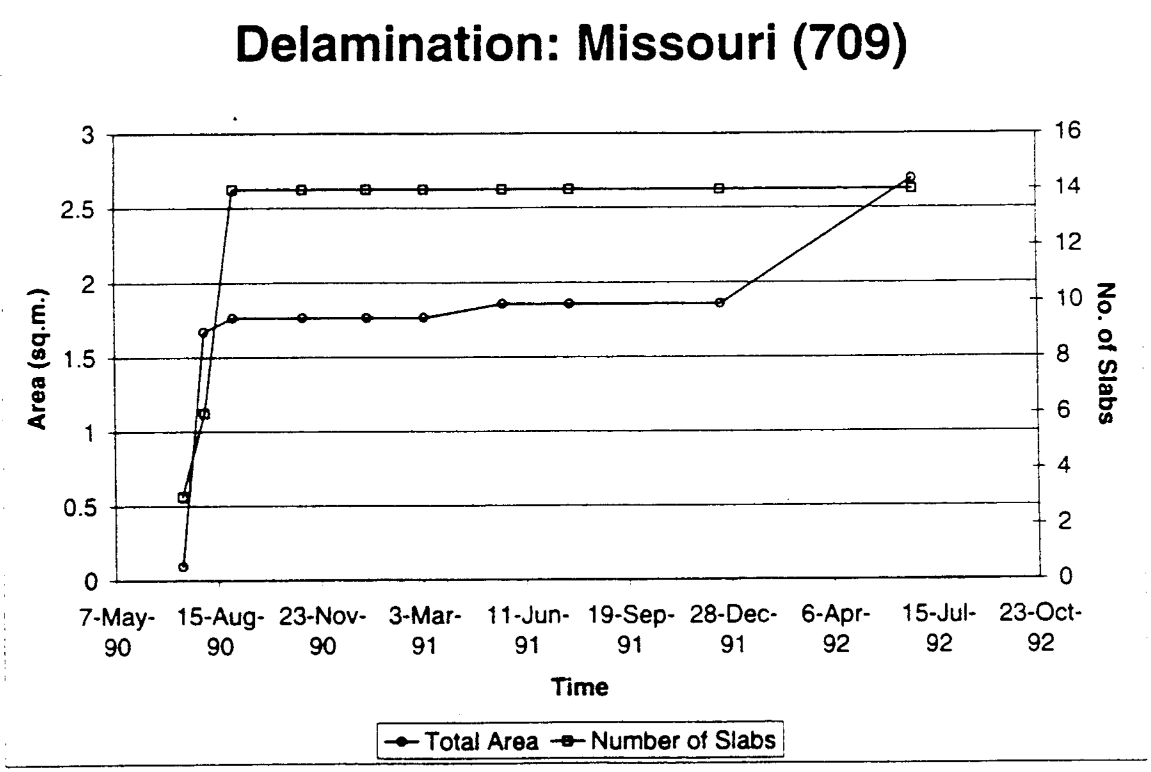

Figure 17. Delamination – Missouri (709).

Table 24. Delamination data for Iowa project site.

Section	Survey Performed Prior to Overlay	Date Survey Performed	Total Area Delaminated, sq m
701	Yes	10/26/93	52.0
702	Yes	10/26/92	0.0
703	Yes	10/26/93	0.0
704	No	10/26/93	0.0
706	Yes	9/26/92	0.9
707	No	10/26/93	1.1
708	Yes	10/26/93	0.0
709	No	10/26/93	0.0

construction reports, but no WIM data are populated in the NIMS. However, WIM data are available for the Iowa and Missouri sites in the regional database.

Deflection Data

All four project sites in the SPS-7 experiment have several years of complete deflection data available for future analyses. Temperature information collected at the project sites at the time of deflection testing is also populated in the NIMS. Deflection testing information is the most populated and complete category of data available for the SPS-7 projects. The maximum normalized deflections for 40 kN (9,000 lbf) for the four project sites versus time are shown in figures 18 through 21. The load transfer efficiencies at transverse cracks and joints versus time for the four project sites are shown in figures 22 through 25. It is clear from figures 18 through 21 that use of a bonded overlay can result in significant pavement strengthening. For the Missouri project, the data are confounded by the excessive delaminations that exist at several test sections.

Other Performance-Related Data

Two other types of performance-related data populated in the NIMS are friction and faulting. The friction data values were reasonable for the type of pavement, but not all four projects have data populated in the NIMS. Five years' worth of friction testing data were available for the Missouri site, 3 years of data for the Iowa site, 1 year of data for the Louisiana site, and no data for the Minnesota site. The average friction values over time for the three project sites with data are presented in figures 26 through 28.

The faulting data populated in the NIMS were for only the Missouri project with the PCC overlay built on a jointed concrete pavement. The faulting measurements are reasonable for most of the data populated in the NIMS. The average section faulting measurements for Missouri are shown in figure 29.

IMPACT OF EXISTING DATA ON FUTURE ANALYSES

Assembling a pool of information for the SPS-7 experiment provides insight into the quantity and quality of data available for future analyses. Three major concerns with the assembled data have appeared that will significantly adversely affect any future analyses: missing data, reliability of collected data, and deviations from specified guidelines.

Missing Data

Data deficiencies (gaps) are prevalent in several categories of data for the four SPS-7 project sites. Complete manual pre-overlay condition surveys are available for only one project site, Louisiana. Manual pre-overlay surveys were stored for approximately 50 percent of the sections at the Iowa site and none for the Minnesota and Missouri project sites. Construction records for the Missouri site state that manual pre-overlay condition surveys were performed, but no records of those surveys were available in the NIMS. Automated pre-overlay surveys are

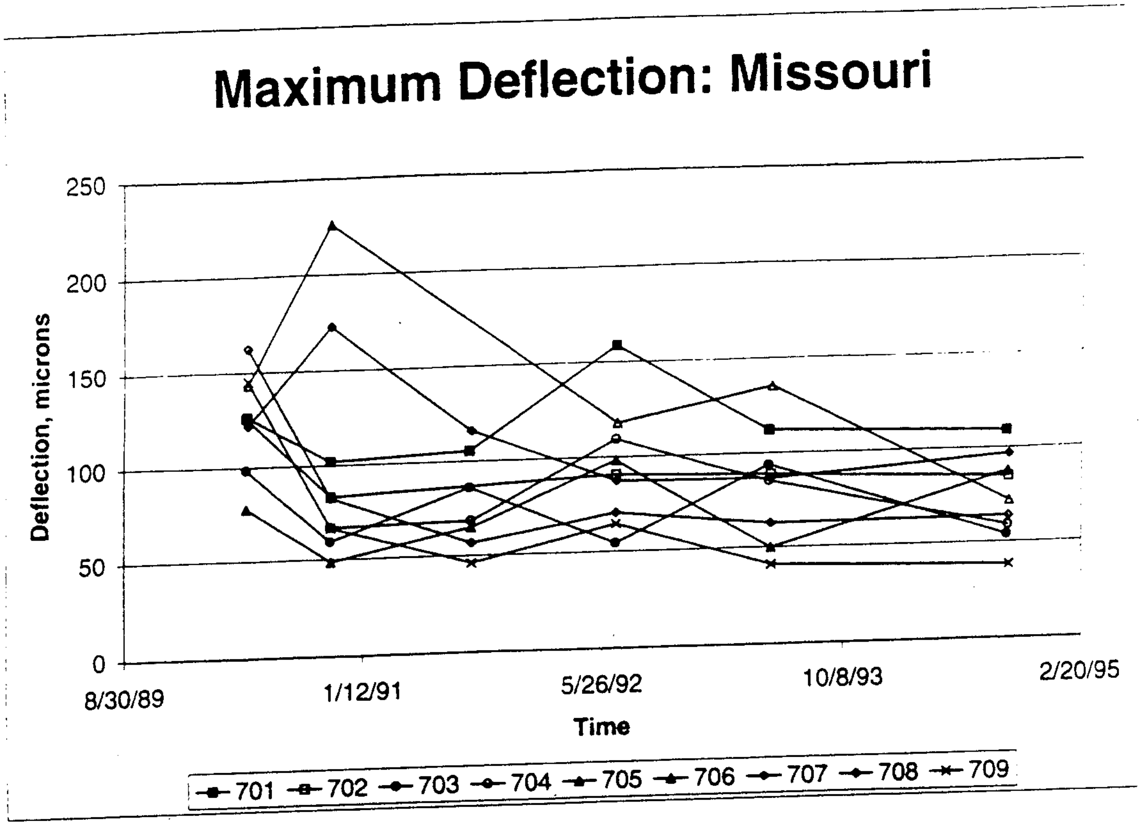

Figure 18. Maximum deflection – Missouri.

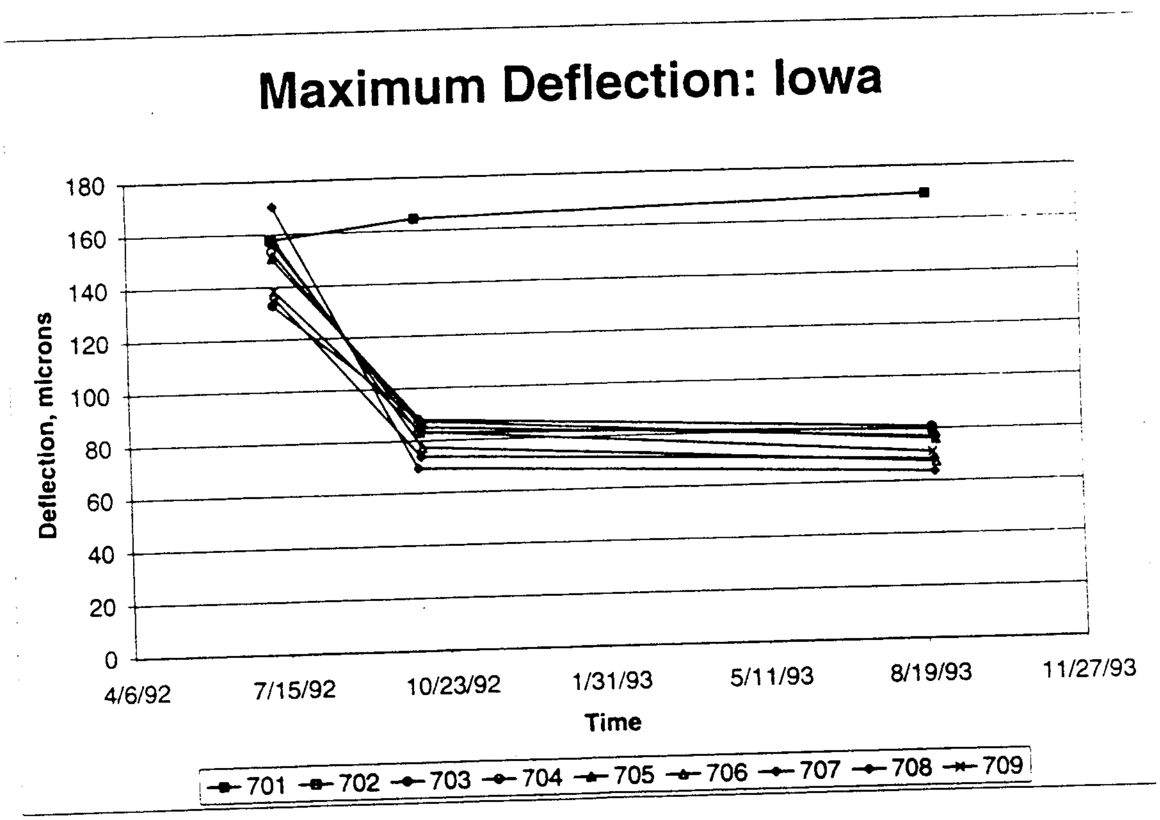

Figure 19. Maximum deflection – Iowa.

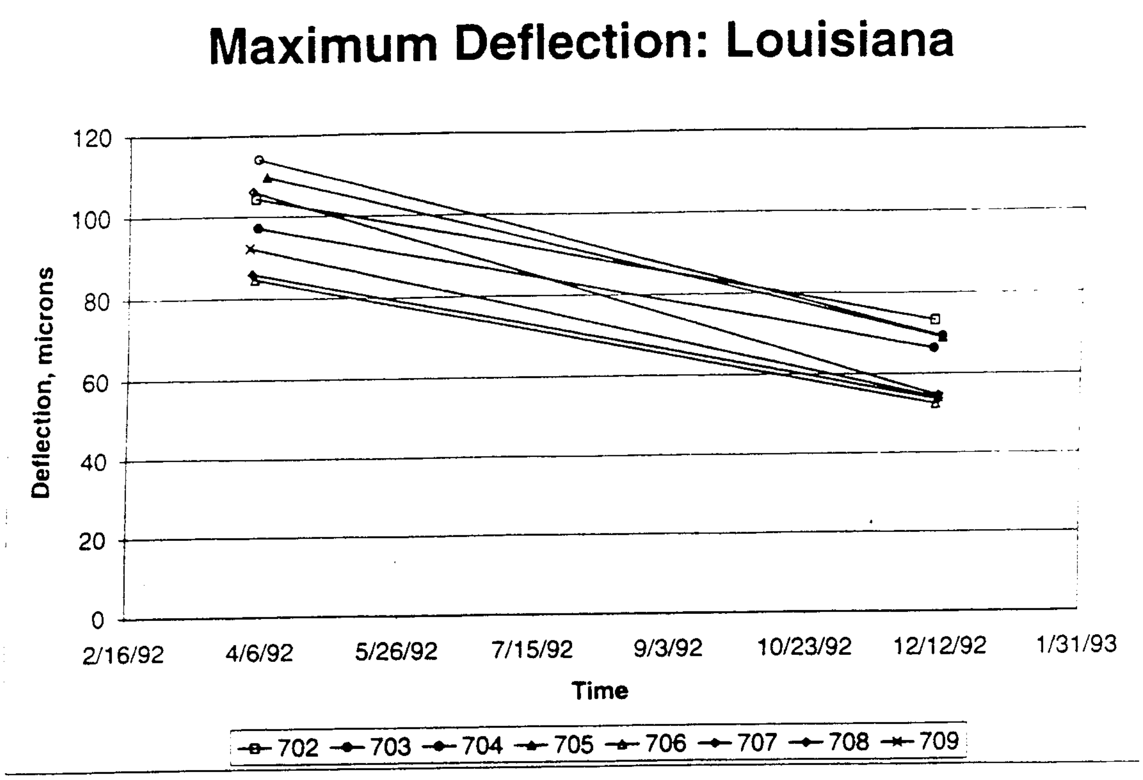

Figure 20. Maximum deflection - Louisiana.

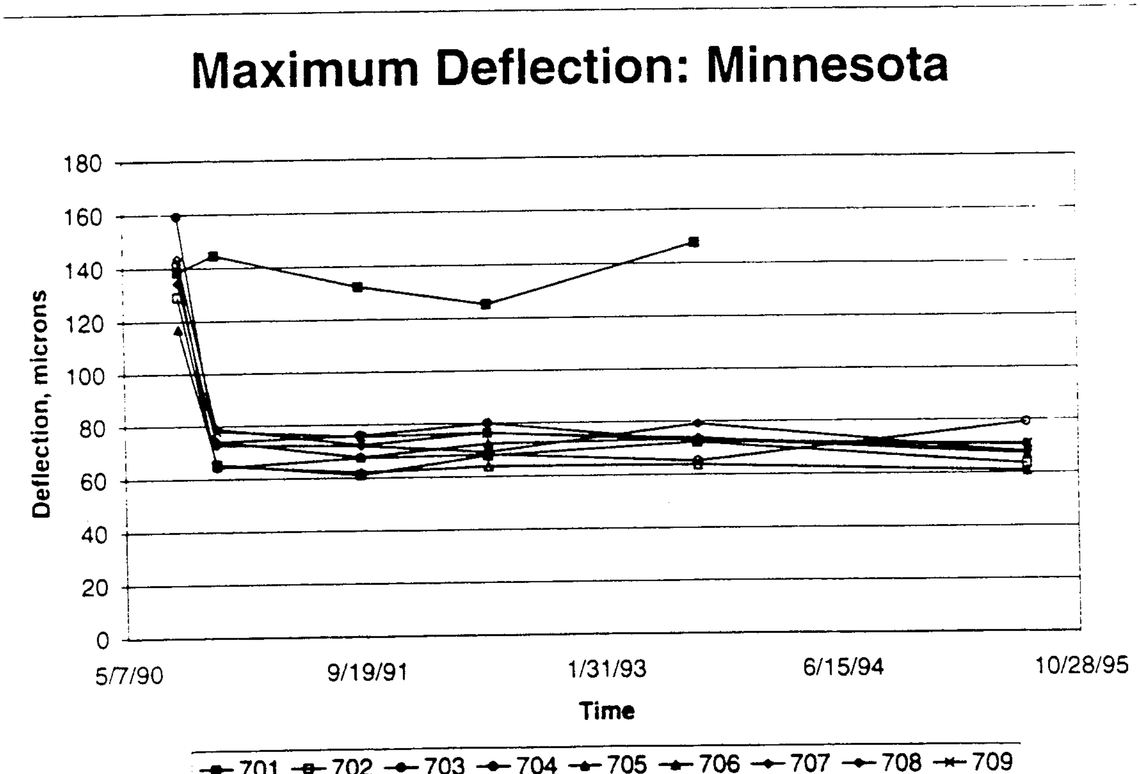

Figure 21. Maximum deflection - Minnesota.

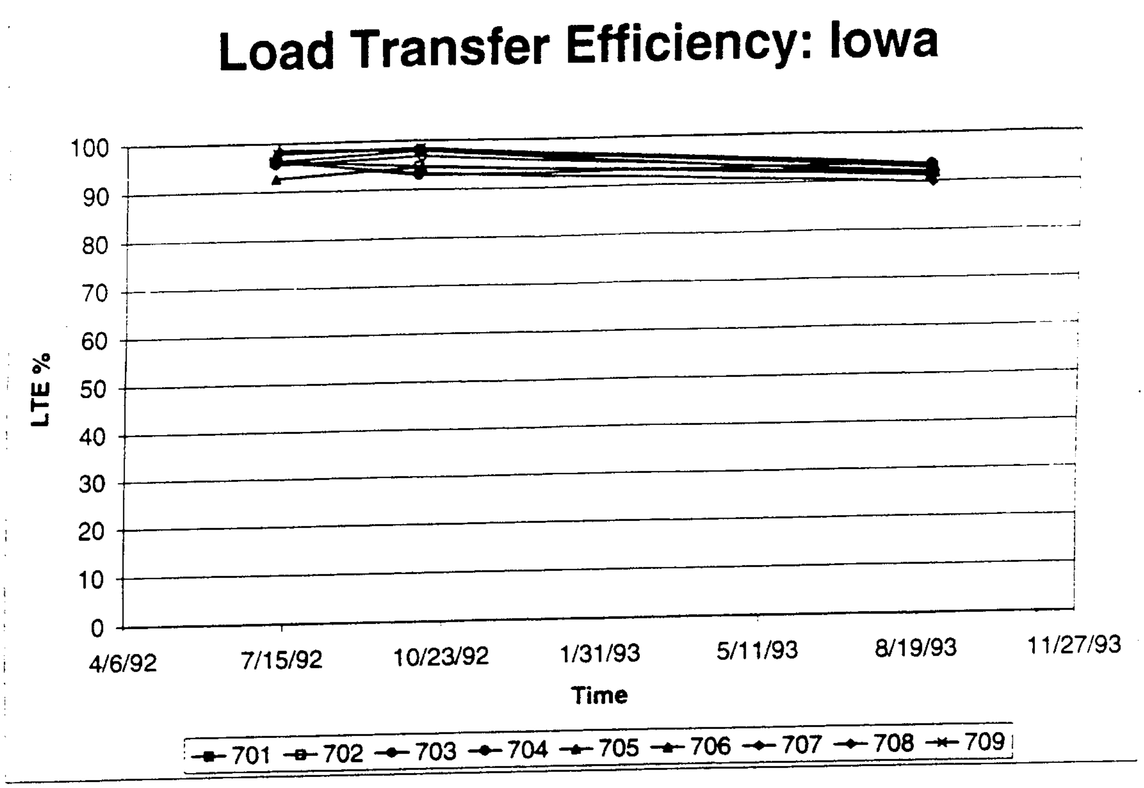

Figure 22. Load transfer efficiency – Iowa.

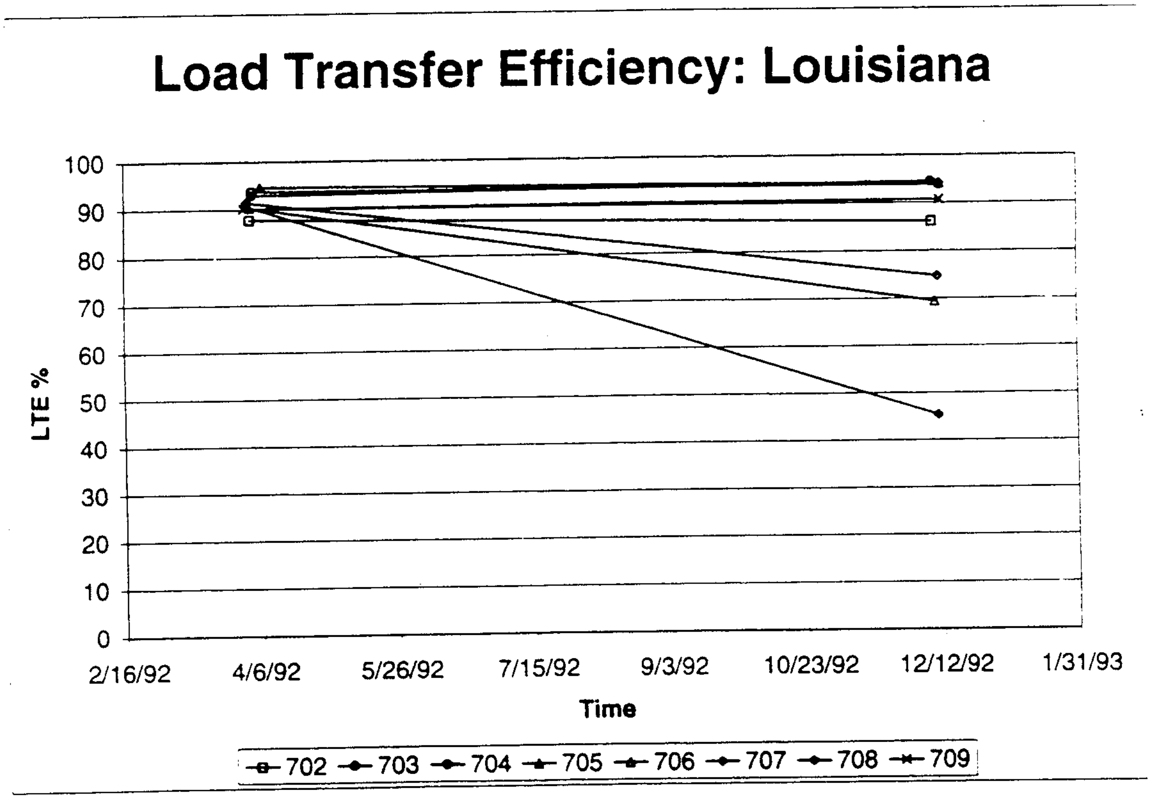

Figure 23. Load transfer efficiency – Louisiana.

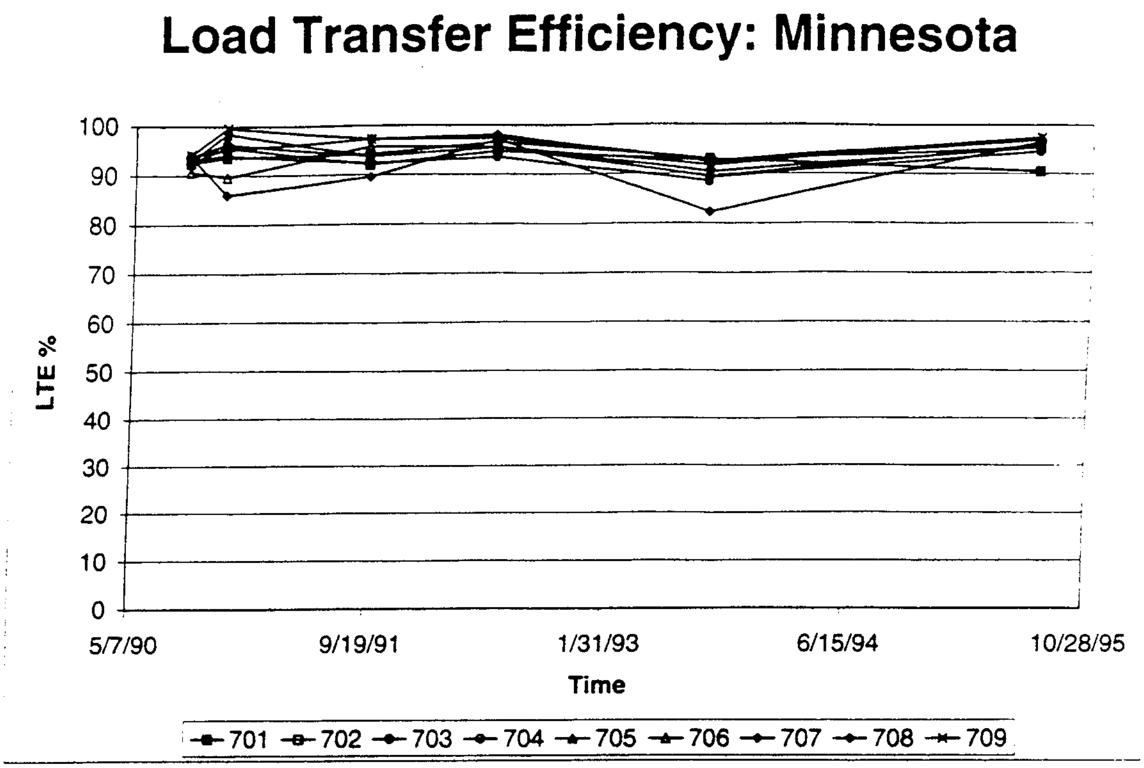

Figure 24. Load transfer efficiency – Minnesota.

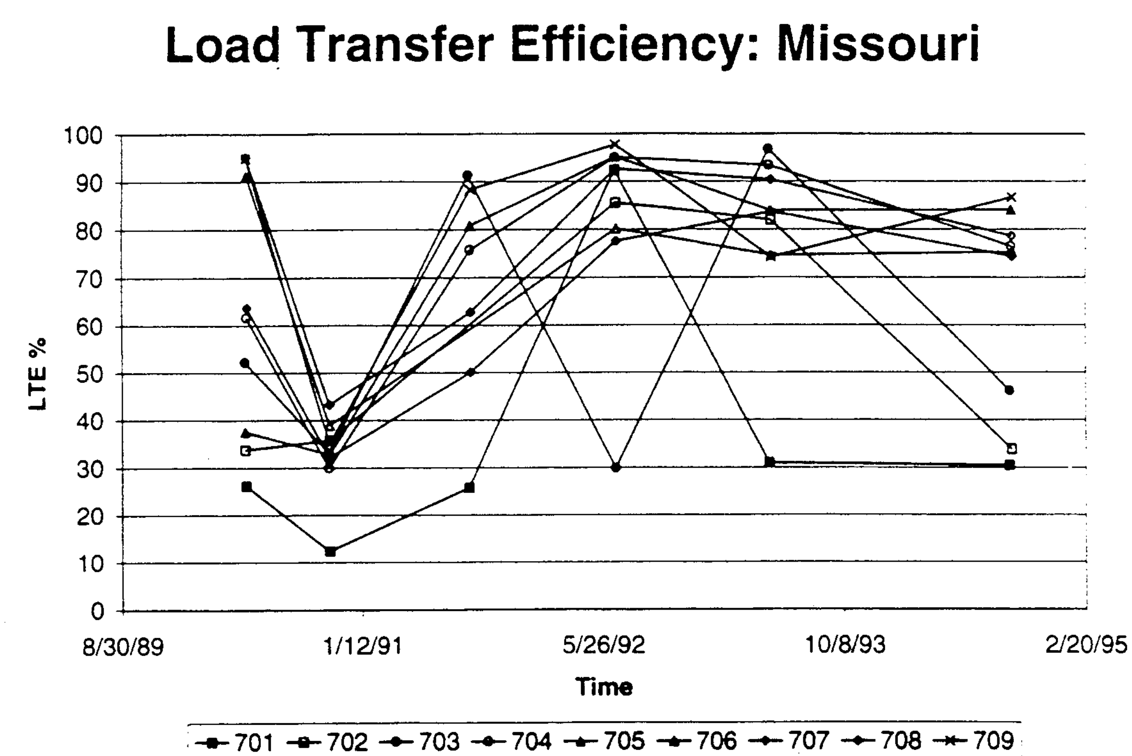

Figure 25. Load transfer efficiency – Missouri.

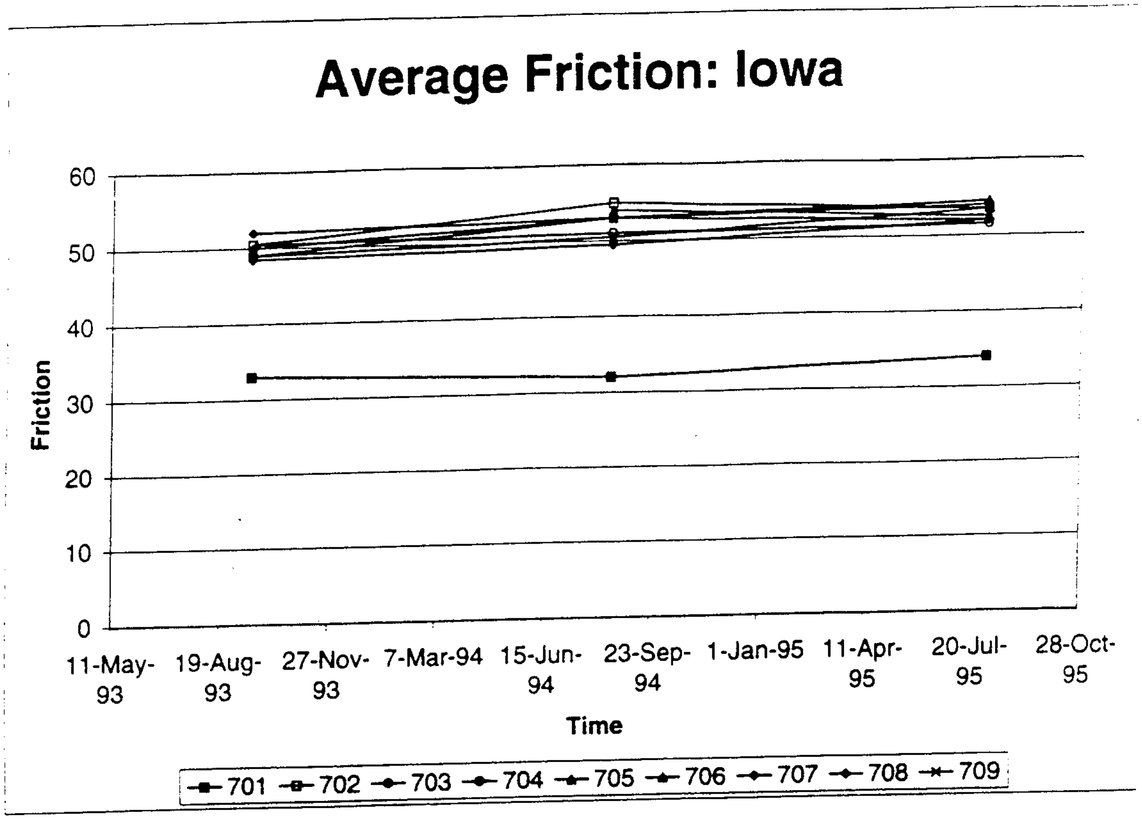

Figure 26. Average friction – Iowa.

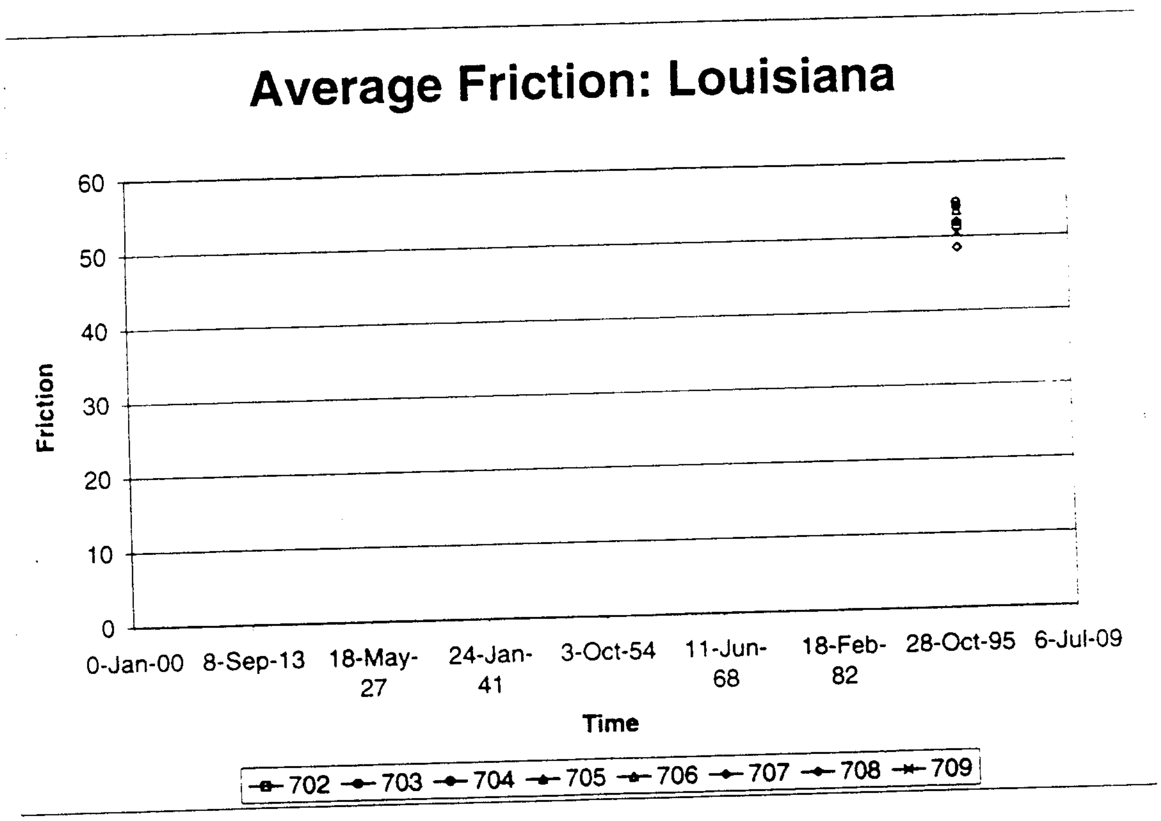

Figure 27. Average friction – Louisiana.

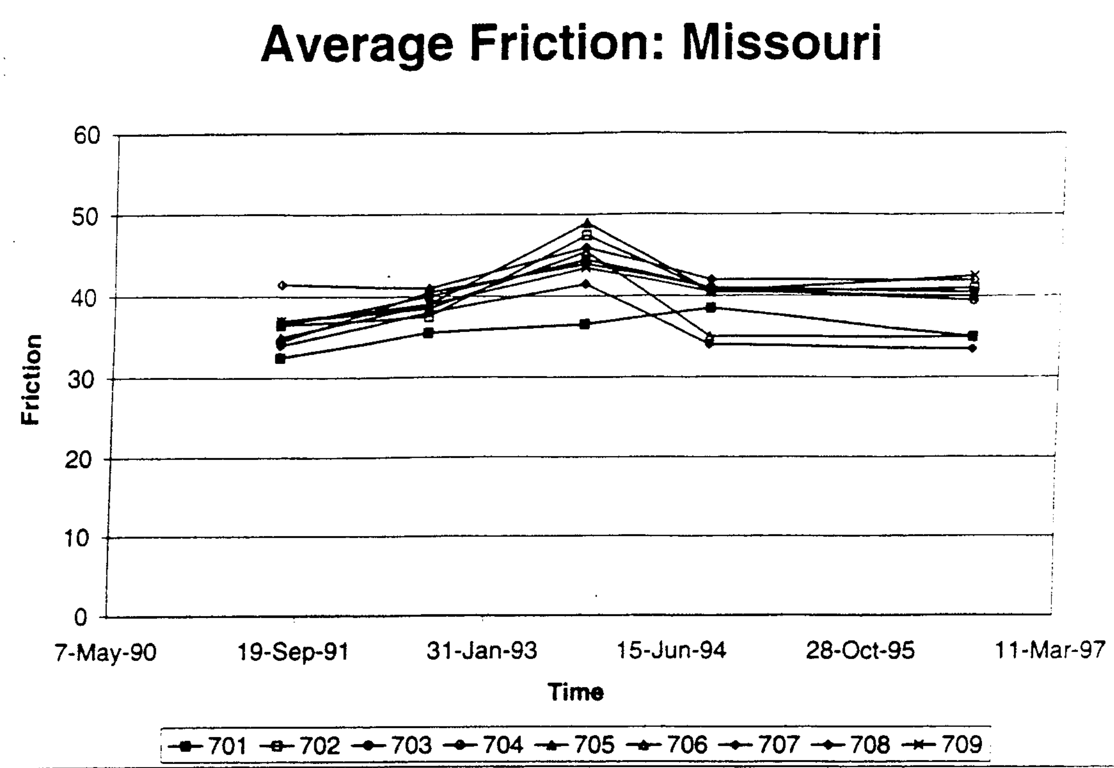

Figure 28. Average friction – Missouri.

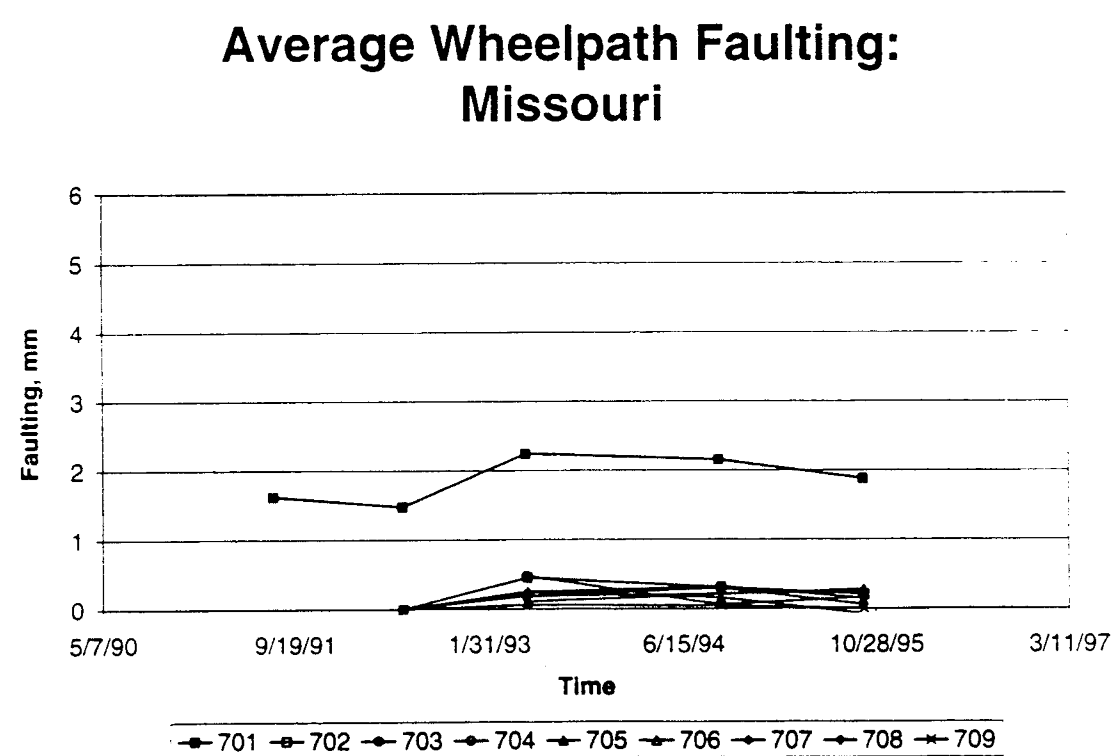

Figure 29. Average wheelpath faulting – Missouri.

available in the NIMS for the Missouri and Minnesota sites, but not for the Iowa and Louisiana sites. Automated condition surveys are currently under interpretation, and additional data should be available in the future.

Material test data are populated in the NIMS for all project sites, but no sites have all types of testing data available for all types of analyses. The Minnesota site is the most deficient in terms of the material test data category. The majority of the sites have material test data for some sections, but rarely for all of the sections. This information can be seen in table 18. The availability of PCC overlay-specific properties (e.g., tensile modulus, compressive strength) is similar to all of the other material properties, in that only some of the sections from a project site have data populated in the NIMS. Minnesota has no data available for PCC overlay-specific material properties. A mechanistic approach to analysis is adversely affected by the lack of complete material test data.

The effectiveness of the bond between the original PCC slab and the PCC overlay, based on a delamination survey, is only available for the Missouri site. All of the other three sites did not perform a delamination survey to monitor the condition of the interface bond.

Traffic data are populated in the NIMS for only the Minnesota project site. The traffic data are complete with axle types and number of repetitions needed for a mechanistic analysis. However, no other SPS-7 project site has traffic data populated in the NIMS.

Profile data were not provided in the data from SAIC and will not be delivered until the latest data are received from all of the regions.

Reliability of Data

Several types of the SPS-7 data assembled for assessment had questionable reliability. Any conclusions derived from analysis using unreliable data are suspect. In order to form significant and definitive conclusions from any analysis, complete and accurate data need to be available and used properly. The two main areas of concern for reliability are the condition survey data and the PCC overlay thickness data.

Manual condition surveys always have an inherent error due to the fact that the surveys are subjective and dependent on the surveyor. Automated surveys often have difficulties identifying very fine cracks that are typical of CRCP. Setting aside those two issues, there are other reliability concerns with the assembled SPS-7 data. The condition survey data stored in the NIMS for the Missouri site have some unreasonable trends, as seen in table 12. The number of recorded cracks drastically changes from one survey to the next in an unreasonable manner.

There are several different sources of PCC overlay thickness data available in the NIMS for the SPS-7 sites. There are three locations with core data (tables TST_LO5B, TST_PC06, and SPS7_LAYER) and one location with rod and level measurements (table TST_LAYER_THICKNESS). All four of these locations of PCC overlay thickness data have different thickness values. The results of any analysis will be affected significantly by the thickness of the overlays. Different results could be attained from the same analyses if the values of the overlay thickness are obtained from different locations.

Deviations from Specified Guidelines

Deviations from the specified guideline of the experiment design could render any performance of the sections insignificant or eliminate the comparison between sections and/or project sites. With only four project sites available for the SPS-7 study, any deviations from the guidelines at these projects result in serious shortcomings. Variations in overlay thickness, the use of grout, and curing conditions were all deviations that occurred in several sections in the SPS-7 experiment.

The overlay thickness was greater than the target value and allowable deviation for all of the sections at three of the project sites (Iowa, Louisiana, and Missouri). The amount by which the overlay thickness was greater than the experimental design was not consistent across all of the sections. The overlay thickness deviation makes comparison between sections and sites difficult.

The Louisiana project site construction had difficulties with the use of the grout in the specified sections, 702, 705, 706, and 709. The grout frequently dried prior to the placement of the PCC overlay. Although attempts were made to correct this deviation, proper placement of the grout was not completely accomplished. This deviation eliminates one experimental parameter in the Louisiana project site.

The curing of the PCC overlay at the Missouri project site did not follow specified guidelines. No curing cover was placed on any of the sections at the Missouri site except one, 703. This deviation may have led to the rapid delamination of the PCC overlay at many of the sections at the Missouri site. The curing conditions of the Missouri sections significantly affect the accuracy of the comparison with other SPS-7 sections.

RECOMMENDATIONS

The main issue regarding the SPS-7 database is whether the current condition of the data can be improved by obtaining missing data and by continuing monitoring of the test sections. Significant findings and conclusions regarding overlay design and service life are not possible with the current condition of the data. It may be possible to develop general trends with regard to surface preparation and the use of grout on a project-by-project basis, but the significance of the results will be limited because of the lack of sample size and some of the deviations in experimental design.

Additional monitoring of the SPS-7 sites will provide information regarding the service life and deterioration trends for the bonded PCC overlays. This information will only provide general trends because of the missing and unreliable data and deviations from specified guidelines.

SUMMARY

It is clear from the foregoing presentation that the SPS-7 experiment has not realized the full potential that had been hoped for. The small number of projects, the compounding effect of missing and poor quality data, and the many construction-related deviations from specifications make the usefulness of the SPS-7 experiment marginal.

The LTPP program continues to face the dilemma of focusing on national experiments versus tackling case study type projects. LTPP's biggest contribution and payoff will result from considering projects that have national significance and broad applications. The SPS-7 experiment, as currently conceived, does not fall into that category.

One of the objectives of the SPS experiment was that the experiment will allow comparisons of "different treatments" within and across projects. The within-project analysis of performance (or effectiveness) of different treatments can be carried out independent of traffic, environmental, and other site features. On the other hand, the across-project analysis of the effectiveness of the various treatments can only be carried out if the necessary data on traffic, environment, and other site features are available.

On the basis of the limited assessment of the SPS-7 data presented in this report, it is clear that the current condition of the SPS-7 database will not support any national or "across-project" analysis of the data. With respect to the within-project analysis, the following key issues need to be addressed:

1. Are the test sections at each project sufficiently different that their performance can be discriminated easily?

2. Are the performances of the different test sections sufficiently different that one can identify factors (treatments) that lead to better or poorer performance?

3. Would additional time-series data contribute significantly to the existing database? In other words, given the condition of the data that exist for the SPS-7 projects, would additional data continue to improve the database (resulting in improved usefulness of the data for the analysis of pavement performance)?

The Missouri SPS-7 project provides an interesting observation. The project provides testimony that, even with significant delaminations and cracking, the overlaid pavements have continued to provide reasonably good service. However, the early development of delamination at several Missouri SPS-7 test sections precludes even a within-project analysis at the Missouri site. With almost 9 years of service life, the Missouri project continues to provide a reasonably good ride, and no major repair activities have been needed. The Missouri project also is one-of-a-kind bonded concrete overlay over an existing jointed plain concrete pavement; as such, it has only limited national/global application.

The three bonded concrete overlay projects over an existing CRCP can be analyzed together to provide reasonably good information on the effectiveness of various bonded concrete overlay techniques. However, across-project analysis cannot be performed unless reliable traffic data are available. At least 5 years of monitored data are available for these three projects.

The experience to date at the four SPS-7 projects has confirmed that well-constructed bonded concrete overlays can be expected to provide pavement strengthening and functional improvement that can extend the service lives of existing concrete pavements. The experience also confirms, as per the Missouri SPS-7 experience, that proper care must be taken during construction to ensure that conditions are not created that lead to overlay delamination. The Missouri experience also confirms that delamination (debonding) occurs within the first few days after overlay placement, and no additional delamination can be expected in the future. However, the early age delaminations do progress into slab cracking. which may manifest over a period of time.

The data available to date also indicate that the SPS-7 experiment may not be able to *fully* resolve the debate about the effectiveness of different surface preparation techniques. In addition, because of the narrow ranges in the actual constructed thicknesses, the distinction between thin and thick overlays has been blurred at many project sites. Thus, it may not be possible to *fully* address the effect of thickness in future analysis.

RECOMMENDATIONS

The following specific recommendations are made:

1. Obtain all missing data from appropriate agencies.

2. Stop future monitoring and testing at the SPS-7 projects.

3. As part of the close-out of each SPS-7 project, perform a complete suite of tests at each test section. These tests include delamination surveys and manual condition surveys.

4. Do not perform any more photographic surveys at the SPS-7 project sites.

REFERENCES

1. *Bonded Concrete Overlay, Route 67, Jefferson County – Construction and 60-Day Survey Analysis*, prepared by the Division of Materials and Research, Research Section, Missouri Highway and Transportation Department, 1991.

2. *SPS-7 Construction Report, Interstate 94, Eastbound Between Moorhead and Baraesville, Minnesota*, prepared by Braun Intertec Corporation for the Federal Highway Administration, June 21, 1996.

3. *SPS-7 Construction Report, I-35 Near Ames, Iowa*, prepared by Braun Intertec Corporation for the Federal Highway Administration, April 1994.

4. *SPS-7 Project 2207: Bonded Concrete Overlay of a Concrete Pavement, IH-10, Eastbound, Ascension Parish, Louisiana*, prepared by Brent Rauhut Engineering, Inc., for the Federal Highway Administration, April 1993.