

CIVIL ENGINEERING STUDIES
Transportation Engineering Series No. 122
Illinois Cooperative Highway and Transportation
Series No. 283

UILU-ENG-2002-2011



ISSN-0197-9191

LONGEVITY OF HIGHWAY PAVEMENTS IN ILLINOIS—2000 UPDATE

by

**Nasir G. Gharaibeh
Michael I. Darter**

A report of the findings of
Enhancements to Illinois Pavement Management

**Project IHR-R24
Illinois Cooperative Highway Research Program**

Conducted by the

**Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign**

and the
Illinois Department of Transportation

In cooperation with the
**U.S. Department of Transportation
Federal Highway Administration**

December 2002

Technical Report Documentation Page

1. Report No. FHWA-IL-UI-283		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle LONGEVITY OF HIGHWAY PAVEMENTS IN ILLINOIS---2000 UPDATE				5. Report Date December 2002	
				6. Performing Organization Code	
7. Author(s) Nasir G. Gharaibeh and Michael I. Darter				8. Performing Organization Report No. UILU-ENG-2002-2011	
9. Performing Organization Name and Address University of Illinois at Urbana-Champaign Department of Civil and Environmental Engineering 205 North Mathews Ave. Urbana, IL 61801				10. Work Unit No. (TRAI5)	
				11. Contract or Grant No. IHR-R24	
12. Sponsoring Agency Name and Address Illinois Department of Transportation Bureau of Materials & Physical Research 126 East Ash Street Springfield, IL 62704-9766				13. Type of Report and Period Covered Interim Report July 2001 to December 2002	
				14. Sponsoring Agency Code	
15. Supplementary Notes Study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.					
16. Abstract Results of the latest round of pavement longevity studies in Illinois provide updated performance data through 2000 for HMAC, JRCP, and CRCP new construction as well as AC overlays (first, second, and third overlays) of these original pavements. The Illinois Department of Transportation (IDOT) has periodically conducted pavement longevity studies to assess the longevity and load carrying capacity of these new and rehabilitated pavements so that any needed improvements to design, construction, or rehabilitation could be identified and implemented in a timely manner. These studies were conducted on over 2000 centerline miles of Interstate and other freeways that were constructed beginning in the 1950's in Illinois. Significant findings were obtained on the performance of the original pavements and overlays that will be of value to designers and administrators to improve pavement cost-effectiveness and life. Key findings show the impact on longevity and load carrying capacity of pavement type (HMAC, JRCP, CRCP), slab thickness, geographic location (north or south), D-cracking, and AC overlay thickness (coupled with pre-overlay condition). The study also provides models for predicting the probability of survival for various designs of original pavements and AC overlays in Illinois for use in pavement management.					
17. Key Words Highway pavement, performance, pavement longevity, flexible pavement, rigid pavement, overlays, rehabilitation, survival analysis, pavement management			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.		
19. Security Classification (of this report) Unclassified		20. Security Classification (of this page) Unclassified		21. No. of Pages	22. Price

TABLE OF CONTENTS

INTRODUCTION	1
IDOT Design, Specifications, Standards, and Policies.....	2
Description of Data.....	3
SURVIVAL ANALYSIS.....	7
Survival of Original Pavements	8
Performance of 10-inch JRCF	8
Performance of 7-inch CRCP	11
Performance of 8-inch CRCP.....	13
Performance of 9-inch CRCP	15
Performance of 10-inch and above CRCP	17
Performance of HMAC	19
Survival of First AC Overlays.....	21
Performance of First Overlays of JRCF	21
Performance of first AC Overlays of CRCP	23
Performance of First AC Overlays of HMAC	25
Survival of Second AC Overlays.....	26
Performance of Second AC Overlays of JRCF	27
Performance of Second AC Overlays of CRCP.....	30
Performance of second AC Overlays of HMAC.....	32
Survival of Third AC Overlays	32
SUMMARY AND CONCLUSIONS.....	33
Longevity of Illinois Freeway Pavements.....	33
JRCF and CRCP	33
HMAC	34
General Longevity and Load Carrying Capacity of AC Overlays	35
AC Overlays—D-Cracking of Existing Pavement.....	36
Thin AC Overlays—JRCF versus CRCP.....	36
Thick AC Overlays/Poor Pre-Overlay Pavement Condition—JRCF, CRCP, and HMAC	36
First and Second-Generation AC Overlays	37
REFERENCES	37
APPENDIX A: DATABASE	

LONGEVITY OF HIGHWAY PAVEMENTS IN ILLINOIS ---2000 UPDATE---

INTRODUCTION

The freeway system in Illinois consists of multiple-lane pavements that were constructed largely since the 1950's. About one-third of these pavements were constructed early on as 10-inch, 100-foot jointed reinforced concrete pavement (JRCP). About two-thirds were originally constructed as continuously reinforced concrete pavement (CRCP) ranging in thickness from 7 to 10 (with a few up to 13) inches. Several sections of full-depth hot mixed asphalt concrete (HMAC) pavements were also constructed in the past two decades.

The Illinois Department of Transportation (IDOT) has now conducted four rounds of pavement survival analysis on over 2000 centerline miles of heavily traveled freeways in Illinois as listed below:

- 1990 using data updated through 1987 (1)
- 1993 using data updated through 1991 (2)
- 1997 using data updated through 1994 (3)
- 2002 using data updated through 2000

The purpose of these periodic studies was as follows:

- Assess the longevity and load carrying capacity of these new and rehabilitated pavements so that any needed improvements to design or rehabilitation policies could be identified and implemented in a timely manner. The pavement expected life and probability of failure may change as the sections age (and carry more load) or when their construction history change (i.e., receive new overlays) over time.
- As more sections fail over time, the analysis becomes more accurate.
- Over time, it became possible to perform the analysis on more pavement families as more sections of these families fail. For example, only in this study it was possible to perform the analysis on more categories of the second and third generation AC overlays
- New updates of the analysis allowed for performing the analysis based on specific requests from IDOT. For example, in the previous studies, the analysis was performed on all original pavement sections in Illinois; in this study the sections were grouped into north (Districts 1-4) and south (Districts 5-9) regions due to the difference in climate between these regions.
- Overall, there were no discrepancies (i.e., unexplained differences) between the four rounds of the analysis. However, there is more confidence in the results of the current round (i.e., this study) due to the improved quality and quantity of data used in the analysis.

The results have provided improved guidance on future decision making on design, materials, construction, and rehabilitation procedures and policies. This report provides the results of the fourth round of the analysis that is based on updated data through March 2000. In addition, the report provides models for predicting the probability of failure or survival for various designs of original pavements and AC overlays in Illinois.

IDOT DESIGN, SPECIFICATIONS, STANDARDS, AND POLICIES

IDOT policies play a significant role in the performance of pavements and overlays over the years. In general, these policies limit the material type and thickness for new construction and rehabilitation of all pavements. The policies ultimately affect the expected life and traffic carried by the pavements. IDOT has constantly sought to improve their design, specifications, standards, and policies over the years. The results of the previous three rounds of survival analyses have been utilized by IDOT to improve all of these activities.

Many modest policy and specification changes to pavement design, materials and construction techniques have also taken place over the years to improve new pavement and overlay performance and lengthen service life. Several policies were enacted for new pavements in 1989 and 1991. A minimum traffic for design use was established for concrete and bituminous concrete pavement, regardless of actual traffic levels (ESALs). The result was a minimum pavement thickness designed for each project. In general, concrete pavements were limited to no less than 10 inches thick and bituminous concrete pavements no less than 13 inches thick. Pavements with a design traffic loading greater than 35 million ESALs are to be designed as a CRCP.

For asphalt concrete (AC) overlays, the thickness of a first generation bituminous concrete overlay of distressed PCC pavement on the Interstate is 3.25 inches regardless of existing pavement design or traffic levels. For pavements with severe distress, additional thickness may be requested. Upon review, overlays of 4 or 5 inches were granted.

Jointed PCC pavement uses larger epoxy coated dowel bars and the joint spacing of the pavement has been reduced to 15 feet to maintain freely moving joints with load transfer. For CRC pavements, they are all now constructed on a bituminous stabilized base and all of the steel is supported on chairs. Epoxy coating of the steel is also specified for severe locations to offset potential corrosion from increased salt usage during snow and ice removal operations. Tie bar size has been increased and spacing decreased to increase edge support on both jointed and CRC pavements. Previously in the early 1980's, improved aggregate specifications were implemented to avoid D-cracking susceptible aggregates.

Many materials and mix design changes have taken place. Anti-strip additives are routinely specified to maintain long-term bituminous concrete durability. Modified asphalt cements may include polymer to minimize cold weather cracking and long-term weathering. New laboratory design methods have lead to aggregate gradation changes to minimize rutting and cracking. Modifications have been placed on the use of high friction aggregate to reduce material variability that resulted in segregation.

Construction improvements asphalt pavements include routinely specifying a material transfer device to minimize mix segregation that has resulted in localized raveling. As smoother pavements have been shown to remain smooth, more stringent smoothness specifications have also begun to be specified requiring more attention to lay down and compaction practices. These improvements and others will have a positive effect on the longevity of Illinois pavements for years to come.

DESCRIPTION OF DATA

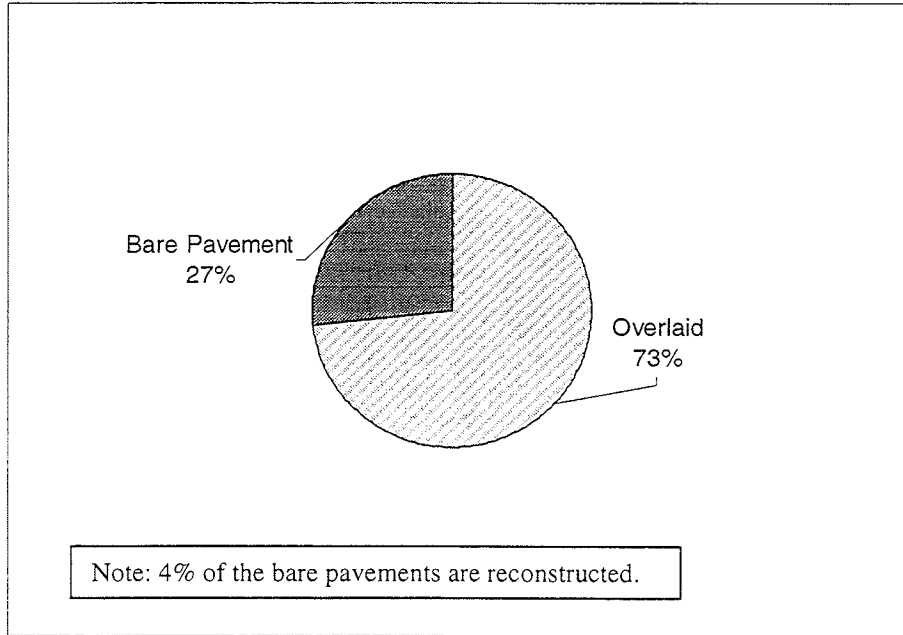
Data for the survival analysis were retrieved from the Illinois Pavement Feedback System (IPFS) database. A pavement construction section typically ranges from 0.5 to over 5 miles in length and represents a consistent design, construction history, and traffic loading for one direction. About 93 percent of all Interstate and other freeway sections were used in this survival analysis (1402 out of 1507 sections representing about 2,000 miles of highway). Sections were excluded from the analysis only if essential information about their original construction, overlays, D-cracking status, or past traffic were not available or were questionable.

As of 2000, about 73 percent of the pavements that are eligible for Interstate Maintenance have been overlaid at least once with AC ranging in thickness from 1.5 to 8.3 inches. About 31 percent have been overlaid at least two times with AC ranging in thickness from 1.5 to 7 inches. About 7 percent have been overlaid at least three times with AC ranging in thickness from 1.5 to 7 inches. A summary of these pavements in terms of overlay history is presented in Figure 1. Figure 2 shows the distribution of the age of bare pavements. The actual survival database used in this study is given in Appendix A.

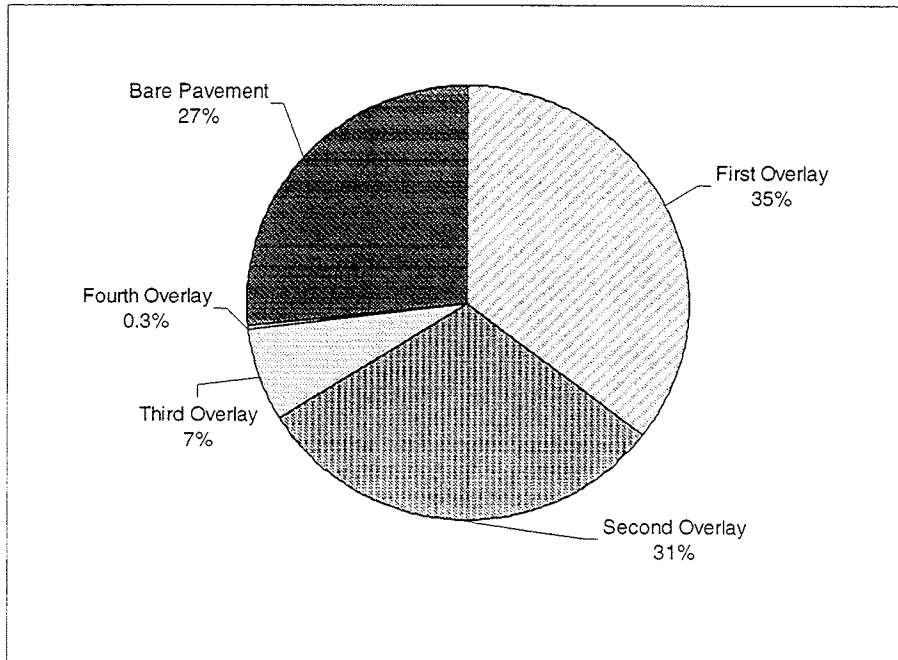
AC overlays were classified as either "thin" (less than 4 inches) or "thick" (4 inches or more). The means and ranges of thin and thick first and second overlays are given in Table 1.

Table 1. Mean and range of AC overlay thickness.

Overlay Category	JRCP			CRCP			HMAC		
	Mean, in	Min, in	Max, in	Mean, in	Min, in	Max, in	Mean, in	Min, in	Max, in
First Thin	3.1	2.5	3.9	3.2	1.5	3.8	2.3	1.5	3.0
First Thick	4.8	4.0	7.0	5.0	4.0	8.3	7.0	7.0	7.0
Second Thin	2.8	1.5	3.8	3.1	1.5	3.5	2.7	2.0	3.3
Second Thick	5.1	4.0	7.0	5.1	4.3	4.8	7	7	7
Third Thin	3.0	1.5	3.5	3.0	1.5	3.5	2.3	2.3	2.3
Third Thick	5.4	4.3	5.8	NA	NA	NA	NA	NA	NA
Fourth Thin	3.1	3.0	3.3	NA	NA	NA	NA	NA	NA
Fourth Thick	NA	NA	NA	NA	NA	NA	NA	NA	NA



A. Percent mileage of bare vs. overlaid pavements.



B. Percent mileage of overlay generations.

Figure 1. Current composition of pavements by percent mileage.

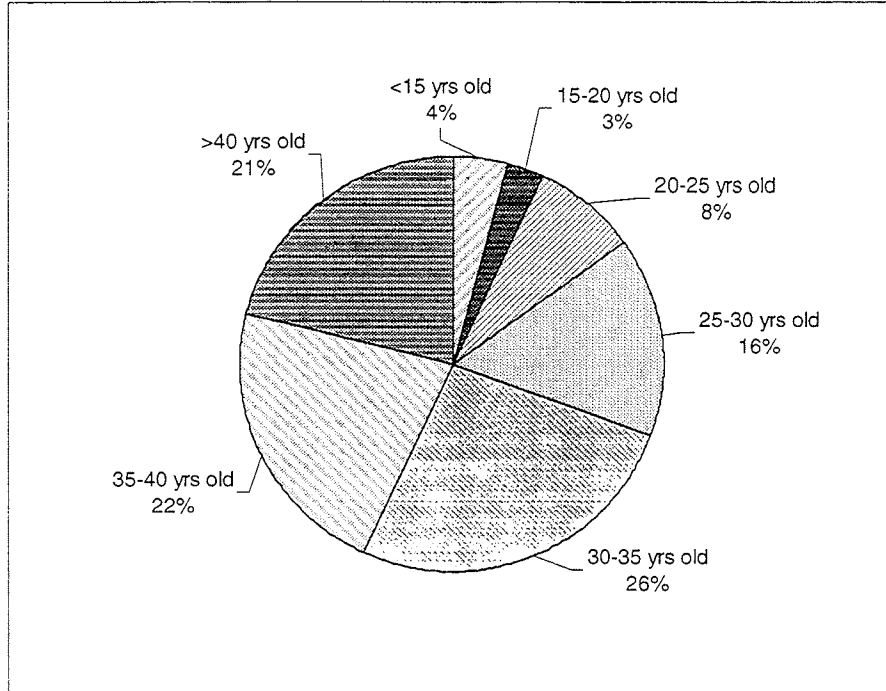


Figure 2. Age of original pavements by percent mileage.

Annual ESALs for each year from construction year to 2001 were also retrieved from the IPFS database for each section. The formula used for computing ESALs is shown below.

$$\text{Annual ESAL} = \frac{a * PC + b * SU + c * MU}{1,000,000} * LDF * 365$$

Where

- Annual ESAL = annual ESALs in design traffic lane in one direction, million
- PC = passenger cars per day, all lanes, two directions
- SU = single-unit trucks per day, all lanes, two directions
- MU = multiple-unit trucks per day, all lanes, two directions
- LDF = lane and directional distribution factor
 - = 0.45 for rural and urban four-lane highways
 - = 0.40 for rural highways with six or more lanes
 - = 0.37 for urban highways with six or more lanes
- a, b, c = Truck factors (for 2001, a = 0.0004, b = 0.3940, c = 1.9080)

Heavy truck traffic loadings on the Illinois freeway system have been far greater than anticipated when these pavements were designed. In 2001, the traffic loading on Illinois freeways averaged about 2.0 million ESALs in one direction in the design traffic lane. As can be seen in Figure 3, the average traffic loading on Illinois freeways for the past 5 decades has increased from less than 0.5 million ESALs annually in the 1960s to approximately 2 million ESALs annually in 2001. These loadings are expected to continue to increase throughout the remainder of this decade.

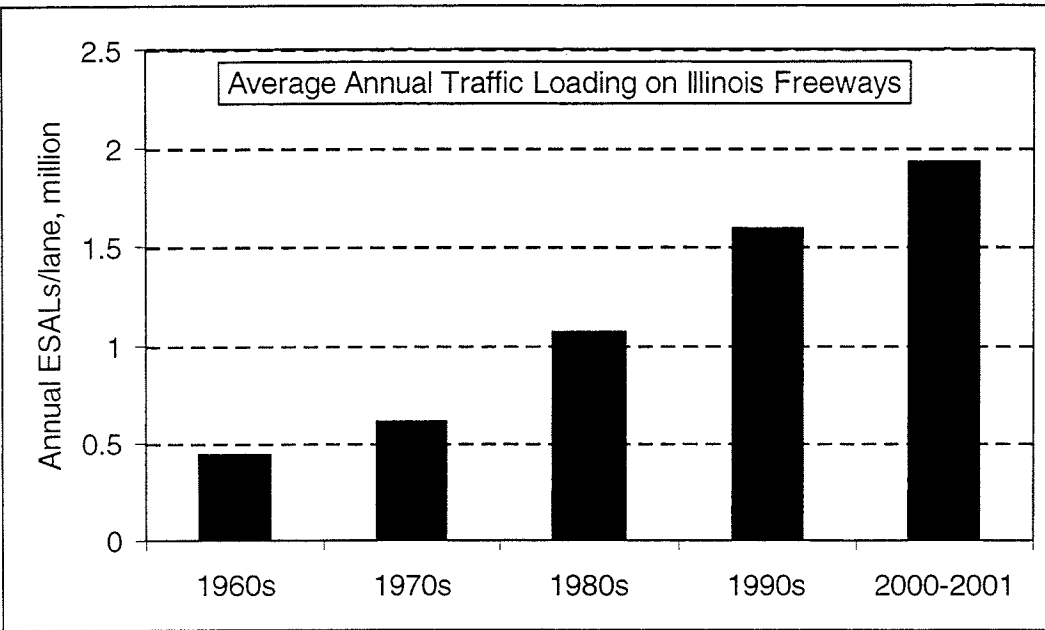


Figure 3. Traffic loading trend on Illinois freeways during the past 5 decades.

SURVIVAL ANALYSIS

The analysis was conducted for each bare pavement type by region of Illinois (northern consisting of Districts 1 to 4 and southern consisting of Districts 5 to 9), and for overlays in categories by thickness (thin and thick) and overlaid pavement type (JRCP, CRCP, and HMAC). For the concrete pavements, separate survival estimates were also obtained for pavements with and without durability cracking (D-cracking) within each bare pavement and overlaid pavement category.

Survival analysis is a statistical method for determining the distribution of lives, as well as the "life expectancy," or mean life, of subjects in an experiment. This analysis method, which is widely used in scientific and actuarial research, is more appropriate than simple computation of an average life of sections (at rehabilitation) when not all subjects (sections) in the experiment have yet reached the end of their life. In statistical terms, the latter are termed "right-censored observations." The mean life and probability of failure are computed considering all sections in the database (failed and non-failed).

Termination of service life of a pavement section ("failure") was defined as major rehabilitation (which nearly always resulted in the placement of an AC overlay). For example, failure of a bare CRCP is defined as placement of an AC overlay. Failure of a pavement section that had been overlaid once was defined as placement of a second overlay. IDOT's pavement management strategy is that overlays are placed only after a pavement has reached an undesirable condition in terms of roughness, distress, and/or large maintenance requirements. This level may vary from section to section of course based on availability of funding and a pavement may be maintained for several years in an undesirable condition. However, the survival analysis is based strictly on when an overlay is placed which is a clear definition.

Both age (which represents the detrimental effects of climatic factors such as temperature cycles, precipitation cycles, oxidation of asphalt, freezing and thawing of PCC, etc.) and traffic loading affect pavement survivability. Therefore, survival curves were generated for each new and overlaid pavement category based on both age (i.e., years) and load carrying capacity as defined by the accumulated 18-kip equivalent single-axle loads (ESALs) in the outer traffic lane. The points for the survival curves were obtained using the LIFETEST procedure available in the PC SAS software. It is important to note that each point represents the probability that a given section will be overlaid when it reaches that age or cumulative ESAL.

Mathematical models were best fitted to the points in the survival curves to predict the probability of survival or failure as a function of age or cumulative ESALs. The general form of these models is as follows:

$$\text{Probability of Failure} = \frac{a}{1 + e^{b*(Age-c)}} + d$$

$$\text{Probability of Failure} = \frac{a}{1 + e^{b*(ESAL-c)}} + d$$

where Age = number of years since construction (new pavement or overlay)
 ESAL = cumulative equivalent single axle loads since construction (new pavement or overlay), millions
 a, b, c, d = regression coefficients determined from analysis

Of course, the probability of survival is computed as (1 – probability of failure). Optimization was used to determine the regression coefficients that best fit the survival points to the above models for each type of pavement and overlay of interest.

SURVIVAL OF ORIGINAL PAVEMENTS

Six pavement designs were analyzed in the original pavement (i.e., bare pavement) survival analysis: 10-inch JRCP; CRCP of 7, 8, 9 and 10-inch or more thickness; and HMAC pavements. The sections in northern Illinois (colder) and southern Illinois (warmer) were analyzed separately. This is to account for the effect of climate (primarily freeze-thaw effects) on pavement performance. The northern region consists of IDOT's Districts 1 through 4 and the southern region consists of Districts 5 through 9. For concrete pavements, the analysis was conducted for sections without D-cracking and sections with D-cracking separately to account for the effect of aggregate quality on pavement performance.

Performance of 10-inch JRCP

This older design consists of a 10-inch PCC slab, reinforcement mesh (0.17%), 100-foot joint spacing, 6-inch granular base, and 650-psi minimum 14-day flexural strength. The longevity (age) and load carrying capacity (ESALs) survival curves for 10-inch JRCPs with and without D-cracking for the northern and southern regions are shown in Figure 4. Table 2 summarizes the data used in this analysis and the probability of failure model for this pavement design.

These curves exhibit the typical survival curve shape. Few pavements fail during the early life but after a given point the rate of failure increases rapidly and then levels off as it approaches 100 percent of sections. Although these pavements have approximately the same design and were built under the same specifications, they include different materials, subgrades, and contractors who built them. The range in life and/or traffic carried from first to last section overlaid is quite large (e.g., age ranges from about 7 to over 30 years and ESALs from a few million to over 40 million). Pavements, similar to other products, are affected by many factors and thus exhibit wide-ranging performance. However, these 10-in JRCP were designed to carry only 5 million ESALs, and over 90 percent carried this level and more and thus they have performed as designed. In fact, traffic has been far higher (more than three times design) on all of these pavements than they were designed to carry over a 20 year design life.

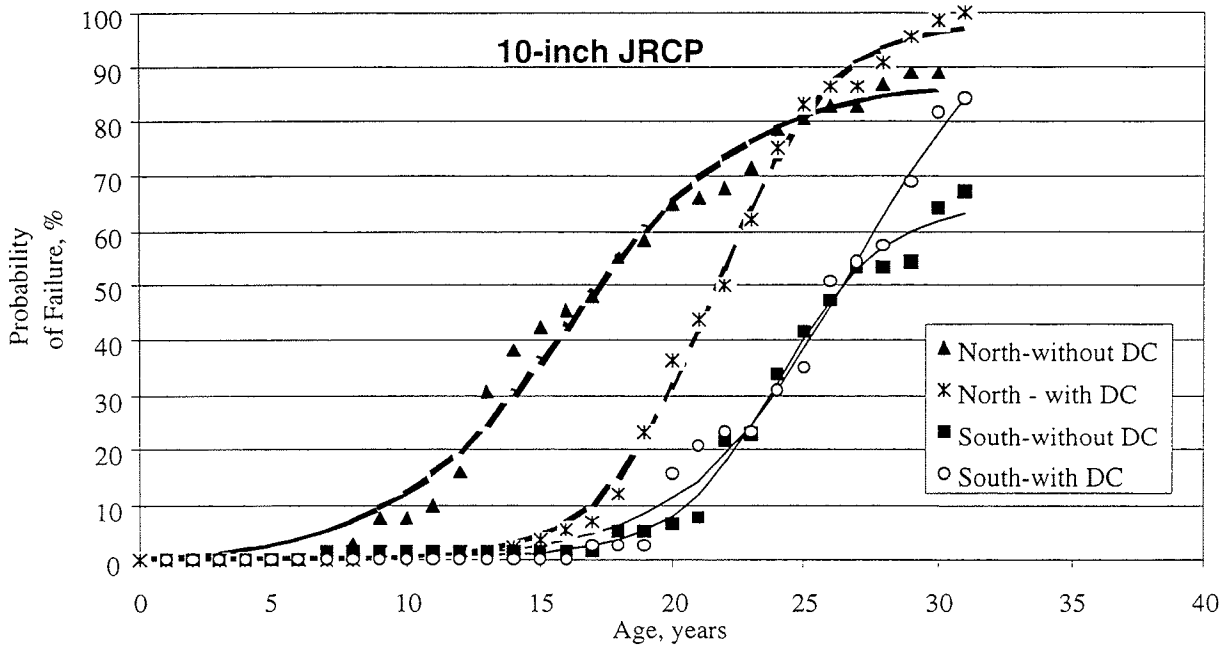
Results show that sections without D-cracking in the southern region have the highest longevity and load carrying capacity at the 50th percentile (26.5 years and 19.5 million ESALs). JRCP in the north without D-cracking had the poorest longevity and load carrying capacity (17.5 years and 10 million ESALs). The reason for this effect on JRCP performance may be related to the colder climate in the north and the unique design of the JRCP. The main structural deficiency of the 100-foot JRCP is the deterioration of mid-panel cracks and joint deterioration. Colder temperatures in winter causes larger opening of mid-panel cracks and transverse joints allowing deicing salts and incompressibles to penetrate and cause reinforcement corrosion and spalling of the joints in the warm months. Dowel bars were part of the original design, but their size and number were substandard for carrying the large overloads. In addition, the bare steel dowels rapidly corroded and would not allow free movement at the joints. This design was not constructed after about 1970 in Illinois due to these weaknesses.

Mixed results were obtained for D-cracking on pavement life. D-cracking was not significant in the north but was detrimental to load carrying capacity in the south (14 million with D-cracking versus 18.5 million ESALs without, a 32 percent increase). No apparent reasons exist for this result in the north and this was not the case for CRCP where D-cracking was very detrimental.

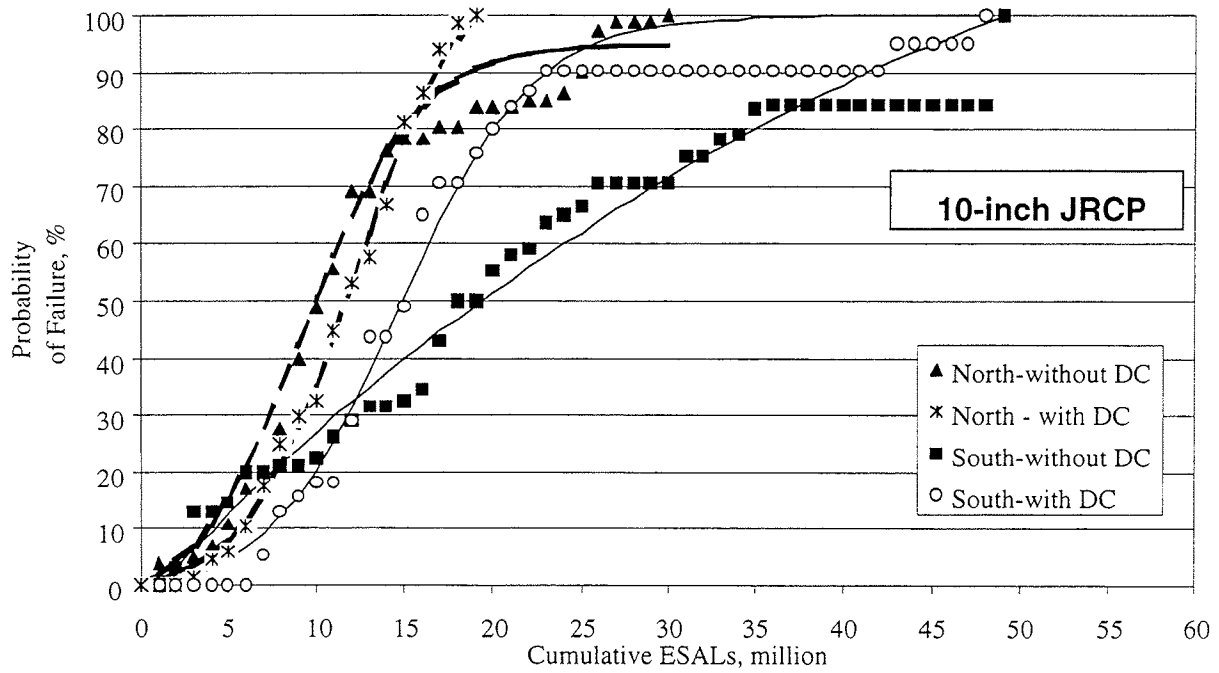
Table 2. Analysis summary and probability of failure model for 10-inch JRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
North - without DC	200	93	13 (6.5)	17.5 (10)	22.5 (14)	-88.27 (-100.2)	0.28 (0.31)	16.15 (9.31)	87.48 (95.05)	30	30
North - with DC	132	100	19 (8.5)	22 (12)	24 (15)	-98.54 (-114.45)	0.46 (0.32)	21.66 (12.28)	98.53 (112.16)	31	19
South - without DC	156	83	22 (8.5)	25.5 (18.5)	NA (31)	-64.71 (-5300.79)	0.49 (0.02)	23.07 (-164.62)	65.18 (158.57)	31	50
South - with DC	77	90	22 (10)	25.5 (14)	28.5 (18)	-108.44 (-102.57)	0.31 (0.27)	25.96 (13.01)	108.40 (100.01)	31	48

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 4. Age and ESAL survival curves for 10-in JRCP.

Performance of 7-inch CRCP

This design consists of a 7-inch PCC slab, 0.5 to 0.75 percent longitudinal steel, usually a 4-inch asphalt-treated base (some granular and cement-treated bases exist), and 650-psi minimum 14-day flexural strength (typically much higher strength is achieved due to high minimum cement content). The age and ESAL survival curves for 7-inch CRCP with and without D-cracking for the northern and southern regions are shown in Figure 5. Table 3 summarizes the data used in this analysis and the probability of failure model for this pavement design.

Results show that D-cracking has a huge effect on the performance of 7-inch CRCP in terms of longevity and load carrying capacity in both northern and southern Illinois. In the north, the non D-cracked 7-inch CRCP lasted 23 years and carried 12 compared to 16 years and 7 million ESALs (71 percent more load carrying capacity) at the 50th percentile. The negative effect of D-cracking was even more dramatic in the south.

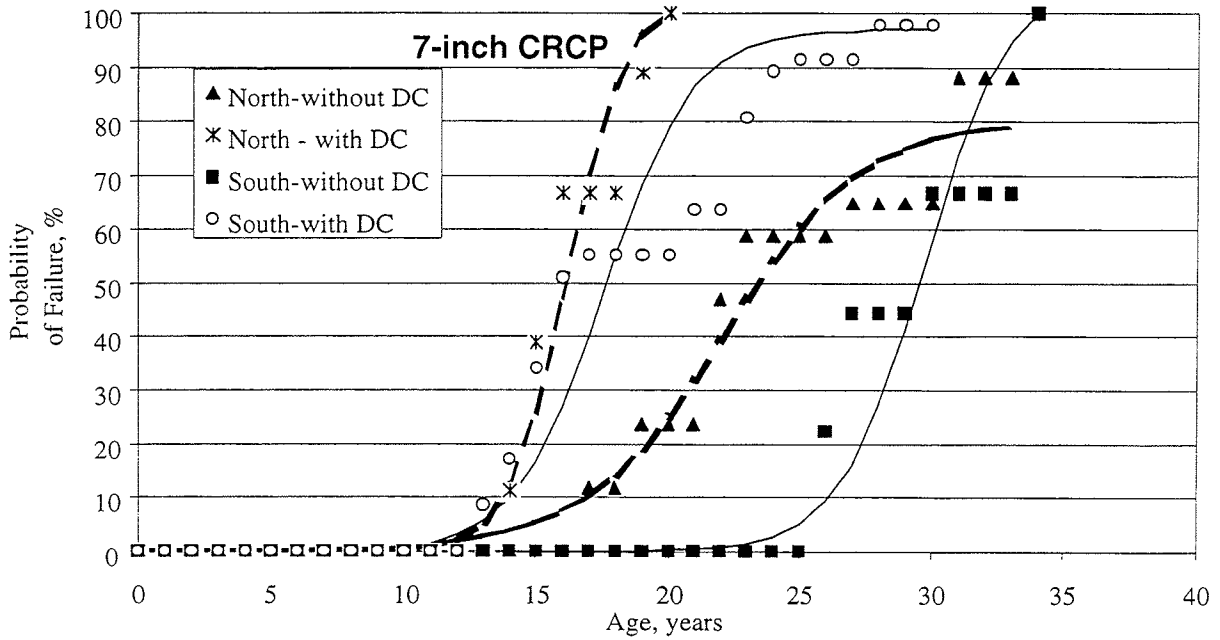
These 7-inch CRCP were designed to carry just 2 million ESALs and over 98 percent of them carried more than this amount and many far more, thus, this design fulfilled its design expectations. The traffic level on these pavements has been much higher than expected.

Note in Figure 5 that whenever there is a horizontal line of data points, this means that there were no additional failures over the age or ESALs of this range, thus the probability of failure does not increase but remains flat. When an additional overlay occurs, the data points jump upward to a higher probability of failure.

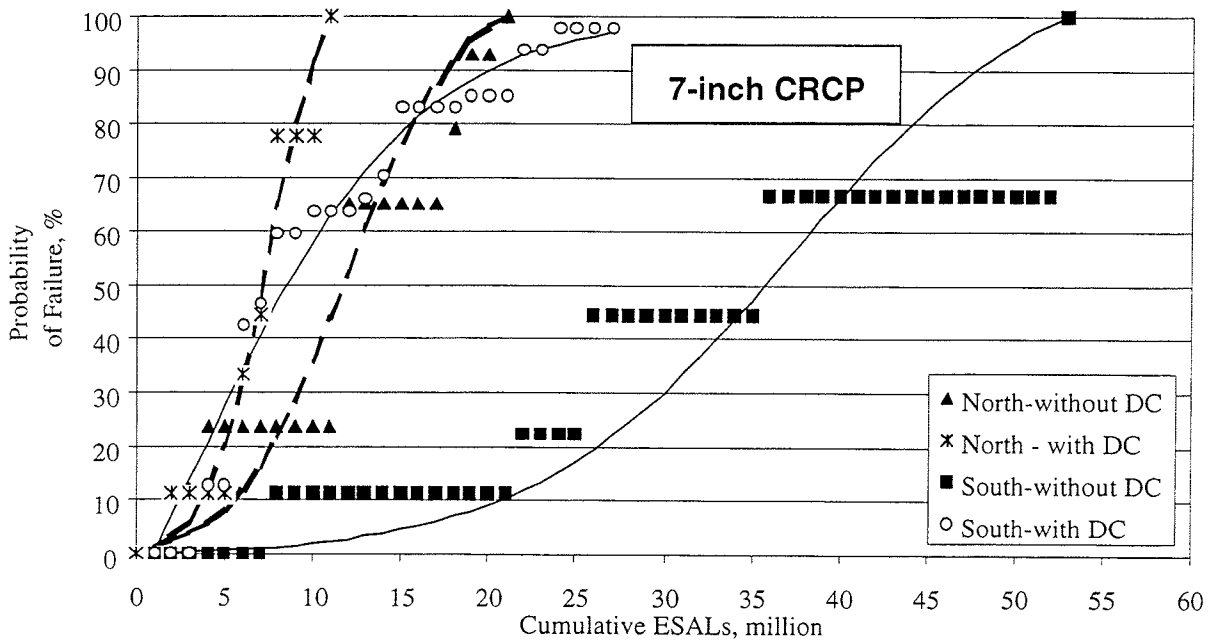
Table 3. Analysis summary and probability of failure model for 7-inch CRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs million
North - without DC	17	88	20 (8.5)	23.5 (12)	29 (15)	-80.36 (-107.77)	0.38 (0.32)	22.10 (11.94)	80.34 (105.58)	33	21
North - with DC	18	100	15 (5.5)	16 (7)	17.5 (9)	102.86 (-113.39)	0.86 (0.60)	16.19 (7.45)	102.86 (112.09)	20	11
South - without DC	9	89	28 (27)	29.5 (35)	31 (42)	-106.56 (-112.24)	0.64 (0.14)	29.72 (36.09)	106.56 (111.44)	34	53
South - with DC	47	98	16 (4)	18 (8)	19.5 (13)	-97.05 (-173.00)	0.62 (0.16)	17.58 (2.04)	97.05 (100.57)	30	27

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 5. Age and ESAL survival curves for 7-inch CRCP.

Performance of 8-inch CRCP

This design consists of an 8-inch PCC slab, with 0.52 to 0.63 percent longitudinal steel, and typically a 4-inch asphalt-treated (a few granular and cement-treated bases also were included). The age and ESAL survival curves for the 8-inch CRCP with and without D-cracking for the northern and southern regions are shown in Figure 6. Table 4 summarizes the data used in this analysis and the probability of failure model for this pavement design.

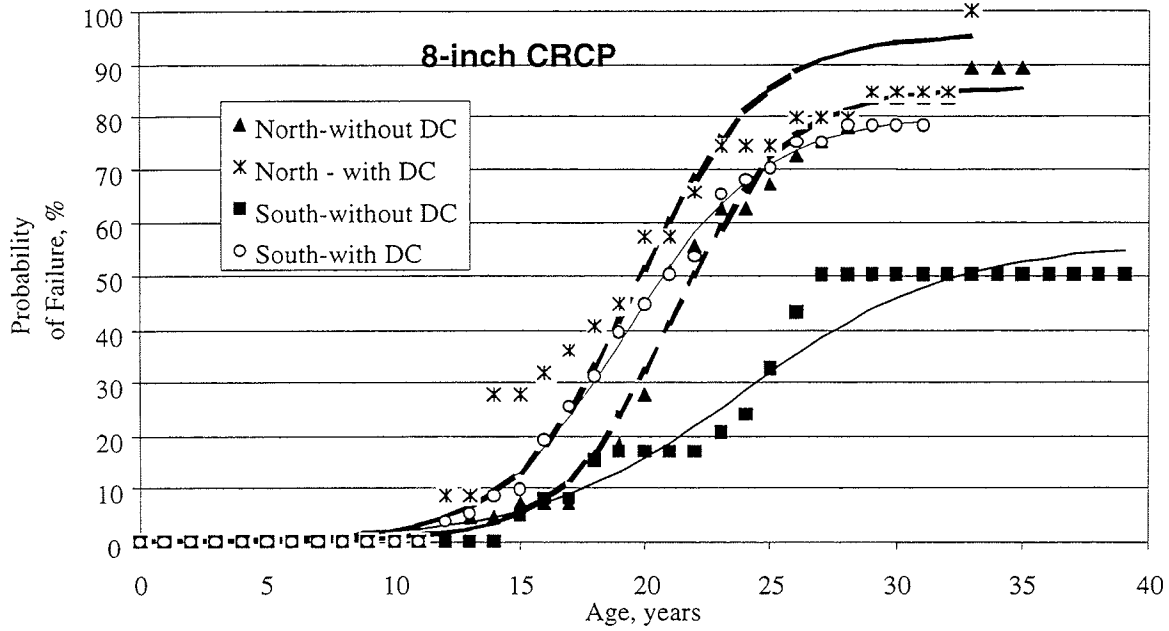
Results are similar to the 7-inch CRCP in that D-cracking has a huge effect on the performance (in terms of age and ESALs carried) for 8-inch CRCP both in the north and in the south. In the south, the non D-cracked 8-inch CRCP lasted 32 years and carried 22 million ESALs compared to 21 years and 13.5 million ESALs (63 percent more) at the 50th percentile.

These 8-inch CRCP were designed to carry 5 million ESALs and over 95 percent of them carried this and much more, even with the D-cracking problem. Thus, this design fulfilled its design expectations. The traffic level on these pavements has been much higher than expected.

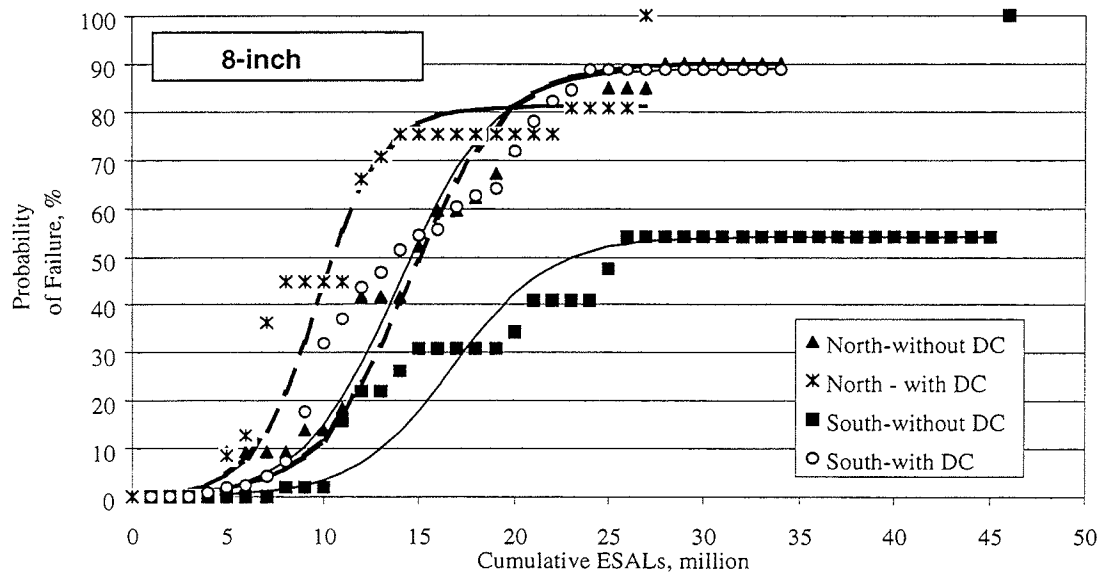
Table 4. Analysis summary and probability of failure model for 8-inch CRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	A	b	c	d	Age, year	ESALs, million
North - without DC	43	86	19 (12)	22 (15)	26 (18.5)	-85.39 (-90.28)	0.44 (0.40)	21.17 (14.54)	85.38 (90.03)	35	27
North - with DC	47	83	17 (8)	20 (10)	23 (14)	-95.52 (-81.28)	0.40 (0.59)	19.63 (9.69)	95.48 (81.01)	33	26
South - without DC	60	40	23 (15.5)	32.5 (22)	NA NA	-55.91 (-54.10)	0.25 (0.40)	23.84 (15.75)	56.05 (54.00)	39	45
South - with DC	212	75	16 (11)	21 (13.5)	27 (17.5)	-80.00 (-89.57)	0.37 (0.39)	19.35 (12.96)	79.94 (89.03)	31	34

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 6. Age and ESAL survival curves for 8-inch CRCP.

Performance of 9-inch CRCP

This design consists of a 9-inch PCC slab, with 0.53 to 0.71 percent longitudinal steel, and a 4-inch asphalt-treated or cement-treated base. The age and ESAL survival curves for the 9-inch CRCP with and without D-cracking for the northern and southern regions are shown in Figure 7. Table 5 summarizes the data used in this analysis and the probability of failure model for this pavement design.

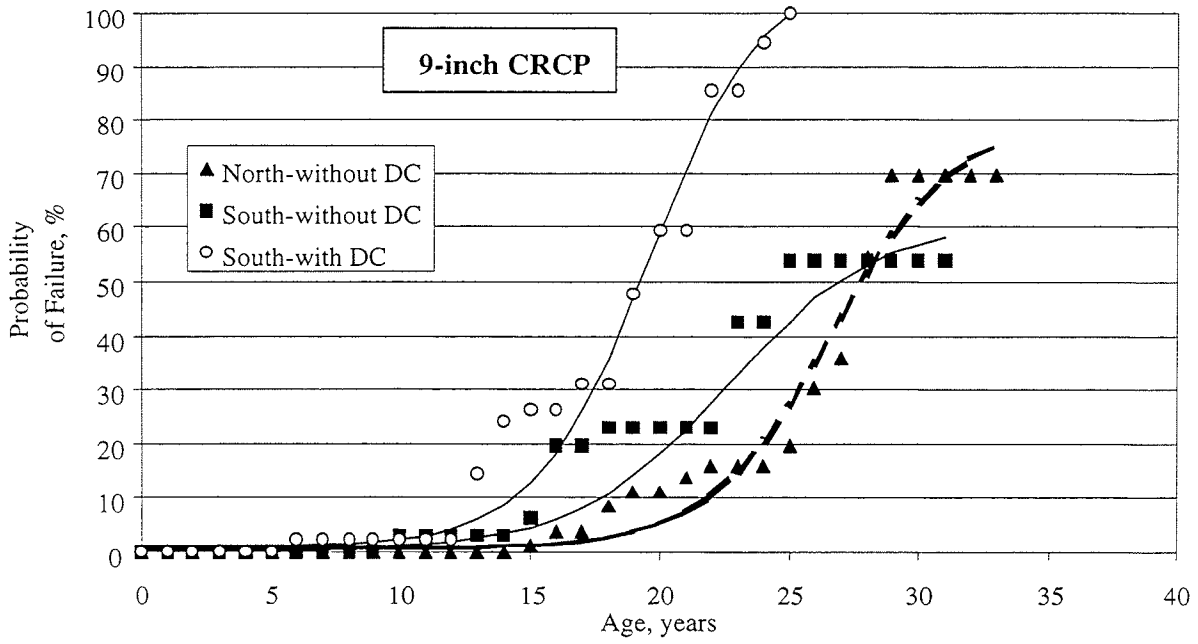
Results are similar to the 7 and 8-inch CRCPs in that D-cracking has a huge effect on the performance in terms of longevity and load carrying capacity for 9-inch CRCP. In the south, the non-D-cracked 9-inch CRCP carried 23 million ESALs compared to 16.5 million ESALs (a 40 percent difference) at the 50th percentile. The age difference was 27 versus 19.5 years (38 percent) at the 50th percentile.

These 9-inch CRCP were designed to carry 10 million ESALs and over 90 percent carried more than this level, thus fulfilling the design expectations. The traffic level on these pavements has been much higher than expected.

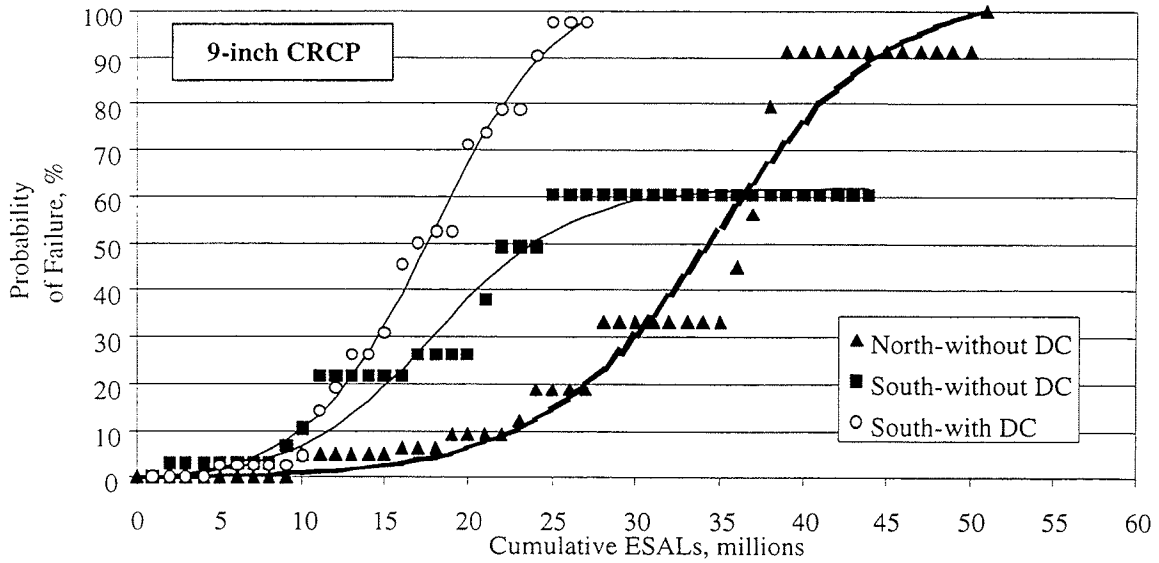
Table 5. Analysis summary and probability of failure model for 9-in CRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
North - without DC	85	49	25 (28.5)	28 (34.5)	33 (40)	-80.19 (-104.97)	0.42 (0.19)	26.71 (34.72)	80.79 (104.80)	33	51
North - with DC	22	18	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA	NA
South - without DC	35	37	22.5 (16)	27 (23)	NA NA	-61.55 (-63.02)	0.34 (0.25)	22.67 (16.98)	61.73 (62.09)	31	44
South - with DC	42	98	17 (13)	19.5 (16.5)	21.5 (20)	-107.55 (-107.54)	0.46 (0.27)	19.64 (16.90)	108.52 (106.44)	25	27

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 7. Age and ESAL survival curves for 9-inch CRCP.

Performance of 10-inch and above CRCP

This design consists of a 10-inch and above PCC slab, with 0.59 to 0.71 percent longitudinal steel, and a 4-inch asphalt-treated or granular base. The age and ESAL survival curve for the 10-inch CRCPs without D-cracking for the northern region is shown in Figure 8. Table 6 summarizes the data used in this analysis and the probability of failure model for this pavement design.

Only the northern region without D-cracking has adequate data to analyze. The age at the 50th percentile is 23 years and ESALs are 40 to 90 million (the exact value is not clear from the survival curve at this point in time). This can be compared directly with the other designs in the northern region without D-cracking at the 50th percentile:

- 10-inch JRCP carried 10 million ESALs over 17.5 years.
- 7-inch CRCP carried 12 million ESALs over 23.5 years.
- 8-inch CRCP carried 15 million ESALs over 22.0 years.
- 9-inch CRCP carried 34.5 million ESALs over 28.0 years.
- 10-inch CRCP carried 40-90 million ESALs over 23.0 years.

The 10-inch JRCP was roughly equivalent to a 7 to 8-inch CRCP in longevity and traffic carrying capacity in the same region of Illinois. Thickness of CRCP obviously has a significant effect on traffic load carrying capacity. These results tend to indicate that the design thicknesses for these sections were very reasonable to produce similar mean lives. This would confirm Illinois' use of a ratio of 0.8 of jointed thickness for CRCP thickness.

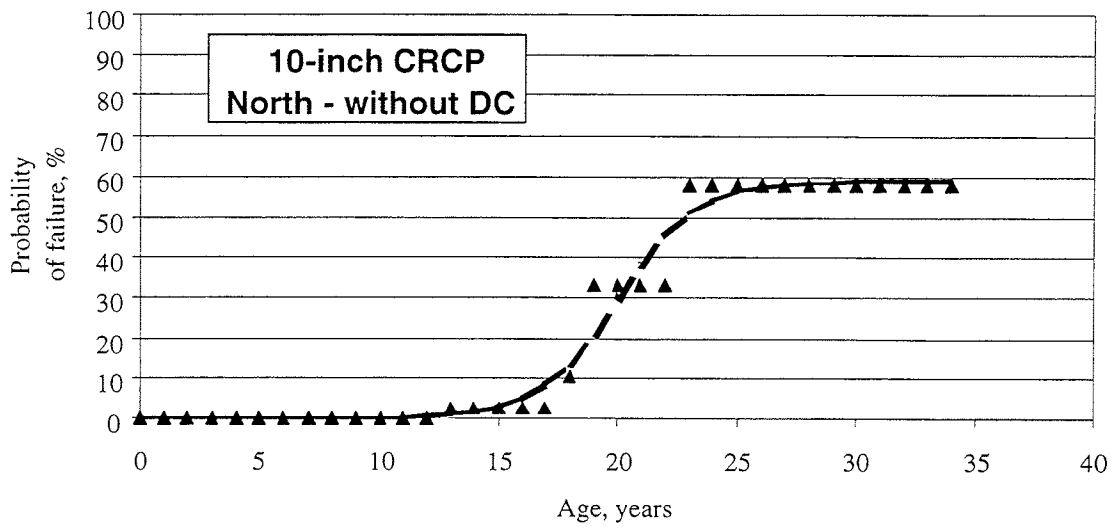
These 10-inch CRCP were designed to carry 21 million ESALs and over 98 percent carried more than this level, thus fulfilling the design expectations. The traffic level on these pavements has been much higher than expected.

Table 6. Analysis summary and probability of failure model for 10-inch CRCP.

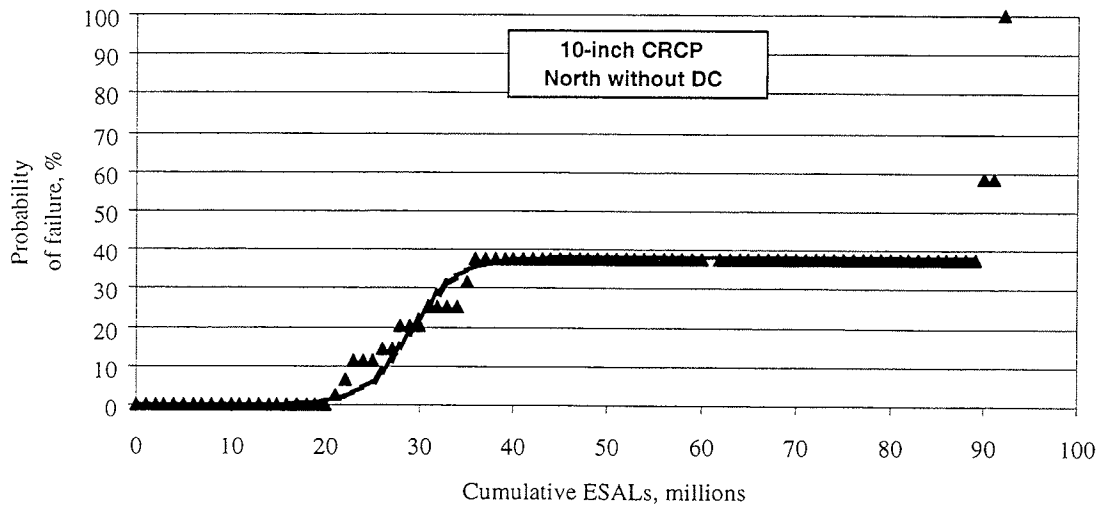
Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	B	c	d	Age, year	ESALs, million
North - without DC	118	23	19.5 (31)	23 (40- 90)	NA NA	-58.84 (-38.00)	0.61 (0.39)	19.98 (29.16)	58.84 (38.00)	34	89
North - with DC	0	0	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA	NA
South - without DC	28**	7	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA	NA
South - with DC	0	0	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA	NA

* The models should not be used beyond these boundaries.

** No model was developed due to limited number of sections and limited number of failed sections.



A. Age survival curves



B. ESAL survival curves

Figure 8. Age and ESAL survival curves for 10-inch CRCP.

Performance of HMAC

This design consists of 12 to 17 inches of asphalt bound material. The age and ESAL survival curves for these pavements for the northern region are shown in Figure 9. Table 7 summarizes the data used in this analysis and the probability of failure model for this pavement design.

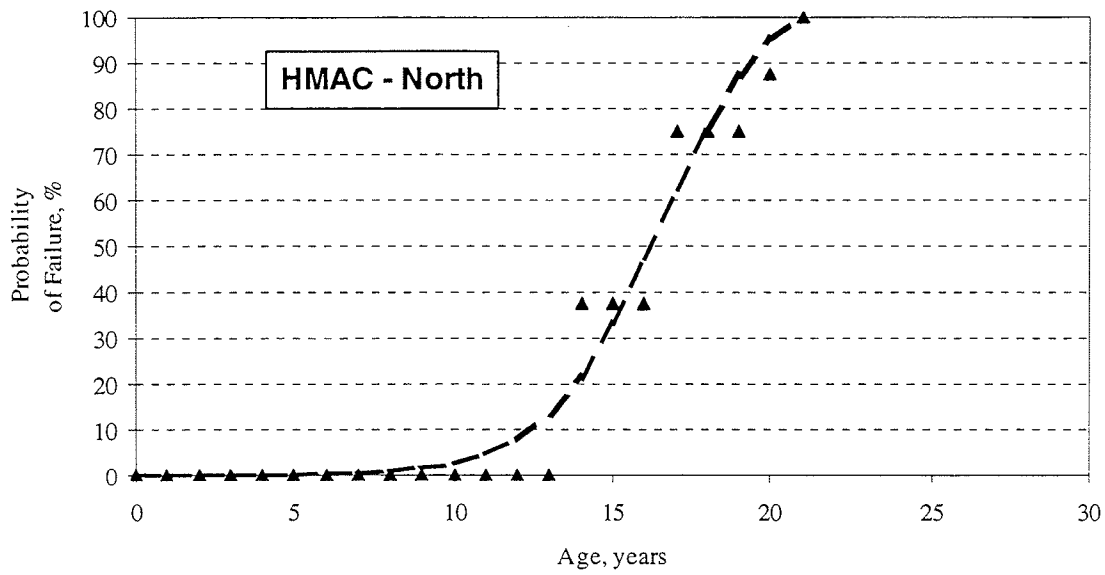
Only the northern region sections have adequate data to analyze. The age at 50th percentile is 16 years and ESALs are 7.5 million. It is noted that the number of sections is limited (20 sections in the north and 34 in the south). There have been no overlays placed in the south sections to date as these are newer pavements. Obviously future survival analyses will more adequately model the longevity of these HMAC pavements and these estimated lives should not be considered as valid at this time.

Current efforts to create a more durable, long-lived surface course are supported by this data as approximately 30 percent of all HMAC pavements did not exceed 15 years in service.

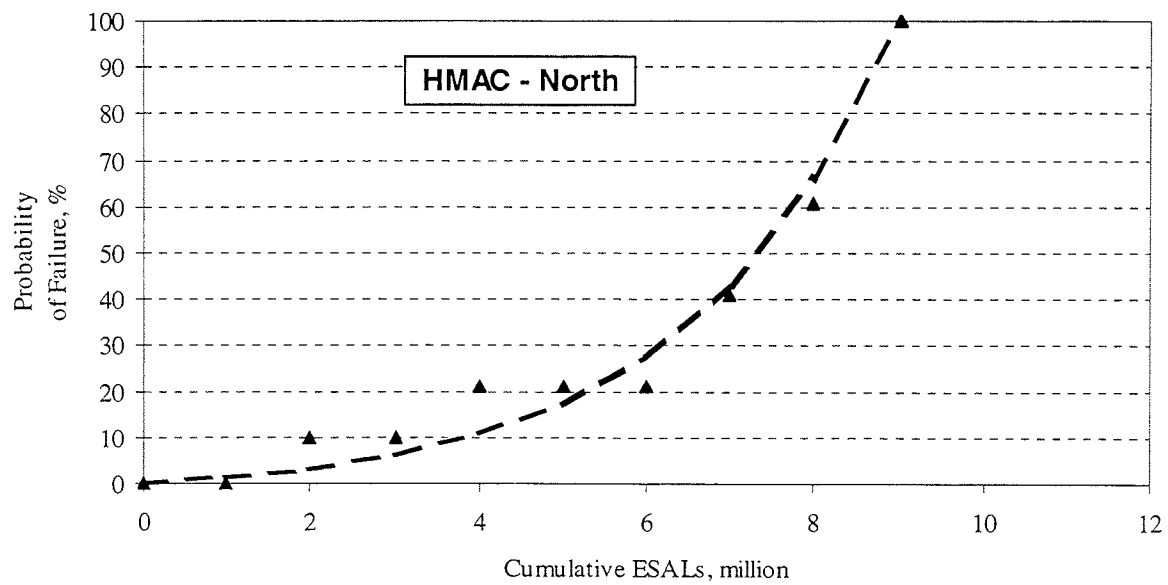
Table 7. Analysis summary and probability of failure model for HMAC.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	B	c	d	Age, year	ESALs, million
North	20	40	14 (6)	16 (7.5)	18 (8.5)	-107.40 (1478.71)	0.57 (0.43)	16.44 (15.10)	107.39 (1476.34)	21	9
South	34	0	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA	NA

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 9. Age and ESAL survival curves for HMAC in the north.

SURVIVAL OF FIRST AC OVERLAYS

Six AC overlay/pavement type combinations were analyzed in the first overlay survival analysis: thin AC overlays of JRCP, thick AC overlays of JRCP, thin AC overlays of CRCP, thick AC overlays of CRCP, thin AC overlays of HMAC, and thick AC overlays of HMAC. There were too few sections to analyze the northern and southern regions separately so the results are combined over the entire State. Sections without D-cracking and sections with D-cracking were analyzed separately. Thin AC overlays were defined as those less than 4 inches, and thick AC overlays were defined as those 4 inches or more. It is important to note that the normal practice is to utilize a thin overlay unless an unusual amount of deterioration has occurred to the existing pavement. Most pavements with thick overlays were in an advanced deteriorated condition at time of overlay.

Performance of First Overlays of JRCP

These AC overlays are placed over 10-inch JRCP. The thin AC overlays have an average thickness of 3.1 inches (ranges between 2.5 and 3.9 inches). The thick AC overlays have an average thickness of 4.8 inches (ranges between 4.0 and 7.0 inches). The age and ESAL survival curves for these AC overlays over JRCP with and without D-cracking are shown in Figure 10. Table 8 summarizes the data used in this analysis and the probability of failure model for this overlay design.

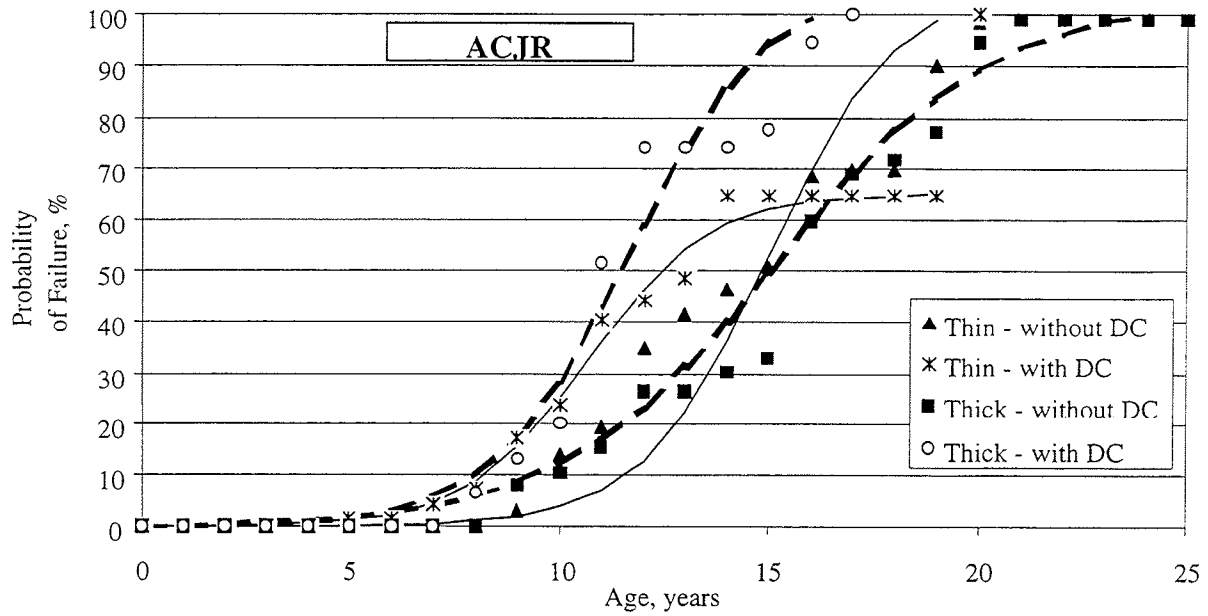
The most significant result is the impact of D-cracking on the load carrying capacity. For thin AC overlays, the 50th percentile ESALs carried were 15 million for D-cracked JRCP versus 22 million for non D-cracked JRCP (47 percent more). For thick AC overlays, the difference was 13 million versus 25 million ESALs (92 percent increase). The load carrying capacity was also lower for bare D-cracked JRCP than non-D-cracked JRCP.

The impact of AC overlay thickness is confounded with the condition of the existing JRCP prior to overlay. In Illinois, only pavements in much worse condition would be overlaid with thick AC overlays. The results for thick and thin overlays over JRCP show about the same life and load carrying capacity indicating that the thicker overlay actually did even out the future performance of the pavement as planned.

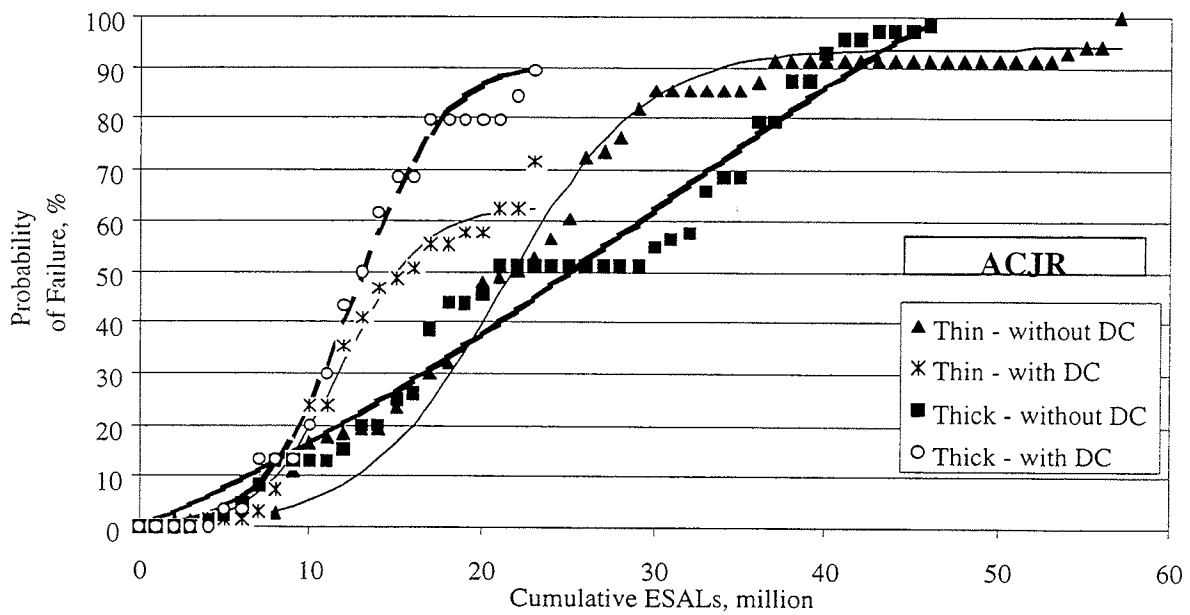
Table 8. Analysis summary and probability of failure model of first AC overlay of JRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	A	b	c	d	Age, year	ESALs, million
Thin ACJR - without DC	229	72	13 (17)	15 (22)	16.5 (27)	-105.69 (-94.52)	0.66 (0.25)	15.00 (21.19)	105.68 (94.02)	19	56
Thin ACJR - with DC	141	53	10 (11)	12.5 (15)	19.5 NA	-65.24 (-63.25)	0.69 (0.43)	10.68 (11.85)	65.20 (62.86)	19	22
Thick ACJR - without DC	86	87	12 (14.5)	15 (25)	18 (35.5)	-103.73 (-177.21)	0.38 (0.06)	15.19 (28.87)	103.42 (147.98)	24	46
Thick ACJR - with DC	60	92	10 (10)	11.5 (13)	13 (16.5)	-105.75 (-92.25)	0.62 (0.39)	11.62 (12.61)	105.67 (91.58)	16	23

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 10. Age and ESAL survival curves for first ACJR.

Performance of first AC Overlays of CRCP

These AC overlays are placed over 7- to 10-inch CRCP. The thin AC overlays have an average thickness of 3.2 inches (ranges between 1.5 and 3.8 inches). The thick AC overlays have an average thickness of 5.0 inches (ranges between 4.0 and 8.3 inches). The age and ESAL survival curves for these AC overlays over CRCP with and without D-cracking are shown in Figure 11. Table 9 summarizes the data used in this analysis and the probability of failure model for this overlay design.

Similar to AC overlays of JRCP, the most dramatic result is the negative impact of D-cracking. For thin AC overlays, the 50th percentile ESALs carried were 22 million for D-cracked CRCP versus 34 million (55 percent more) for non-D-cracked CRCP. For thick AC overlays, the effect was 10.5 million versus 21 million ESALs (100 percent more). The longevity was also much lower for D-cracked CRCP than non-D-cracked CRCP.

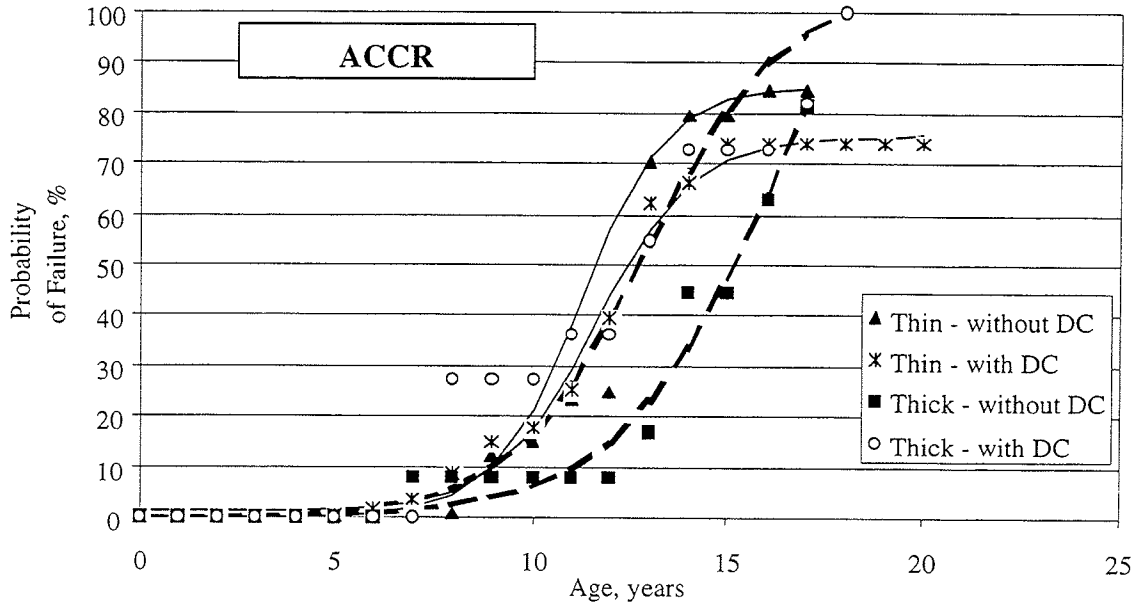
Comparison of the performance of AC overlay thickness shows that the thin overlays carry significantly more traffic loads than the thick AC overlays (62 percent more without D-cracking and 109 percent more with D-cracking). This result is due the fact that thick overlays are placed on existing pavements that are much more deteriorated than pavements where thin overlays are placed.

Comparison of first AC overlays of non D-cracked JRCP and CRCP shows that the thin AC overlays over CRCP carry 54 percent more traffic than over JRCP (due to reduced reflection cracking from transverse joints and deteriorated cracks), but the thick AC overlays show approximately the same performance over badly deteriorated CRCP or JRCP. The thicker AC overlays are placed on very badly deteriorated CRCP or JRCP and show the same longevity and ESALs for both pavement types.

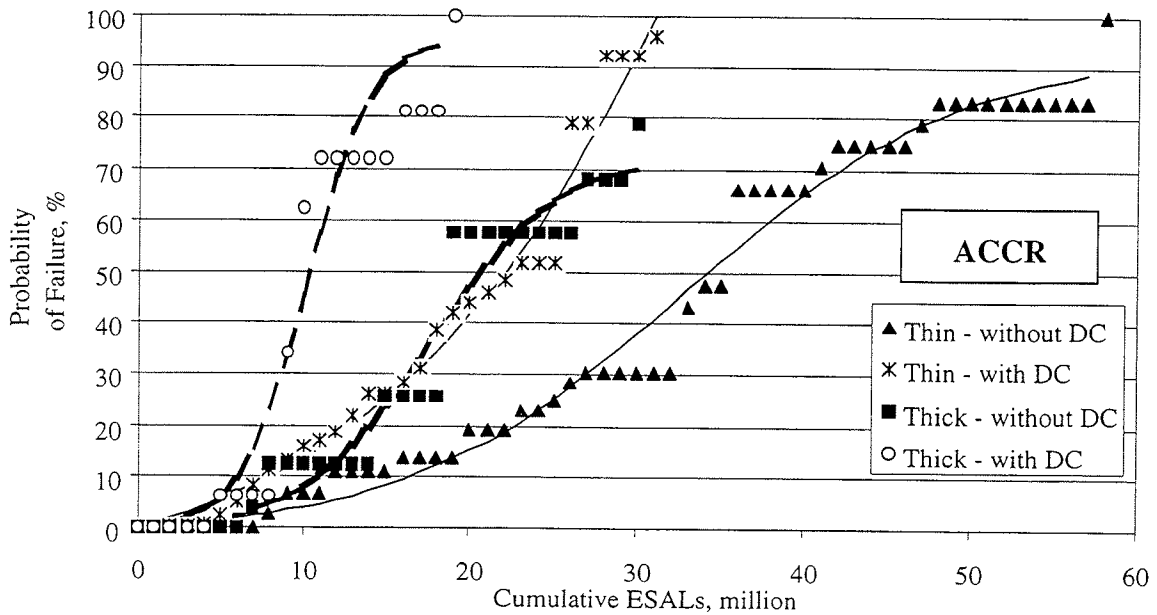
Table 9. Analysis summary and probability of failure model for first ACCR.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
Thin ACCR - without DC	126	39	10 (25)	12 (34)	13.5 (45)	-85.46 (-95.38)	0.90 (0.12)	11.23 (32.75)	85.46 (93.53)	17	57
Thin ACCR - with DC	259	46	11 (15)	12.5 (22)	18 (27)	-74.55 (-527.82)	0.79 (0.08)	11.62 (47.56)	75.57 (515.96)	20	31
Thick ACCR - without DC	42	24	13 (15.5)	15 (21)	16.5 (29.5)	-146.67 (-73.24)	0.48 (0.27)	16.54 (17.57)	146.62 (72.61)	17	30
Thick ACCR - with DC	48	46	11 (8)	13 (10.5)	14.5 (13)	-105.36 (-96.59)	0.58 (0.51)	12.93 (10.21)	105.30 (96.07)	18	18

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 11. Age and ESAL survival curves for first AC overlay of CRCP.

Performance of First AC Overlays of HMAC

These AC overlays are placed over HMAC pavements that have an average thickness of 15.9 inches (ranges between 12.0 and 17.5 inches). The thin AC overlays have an average thickness of 2.3 inches (ranges between 1.5 and 3.0 inches). The thick AC overlays are 7.0 inches in thickness. The age and ESAL survival curves for these overlays over HMAC are shown in Figure 12. Table 10 summarizes the data used in this analysis and the probability of failure model for this overlay design.

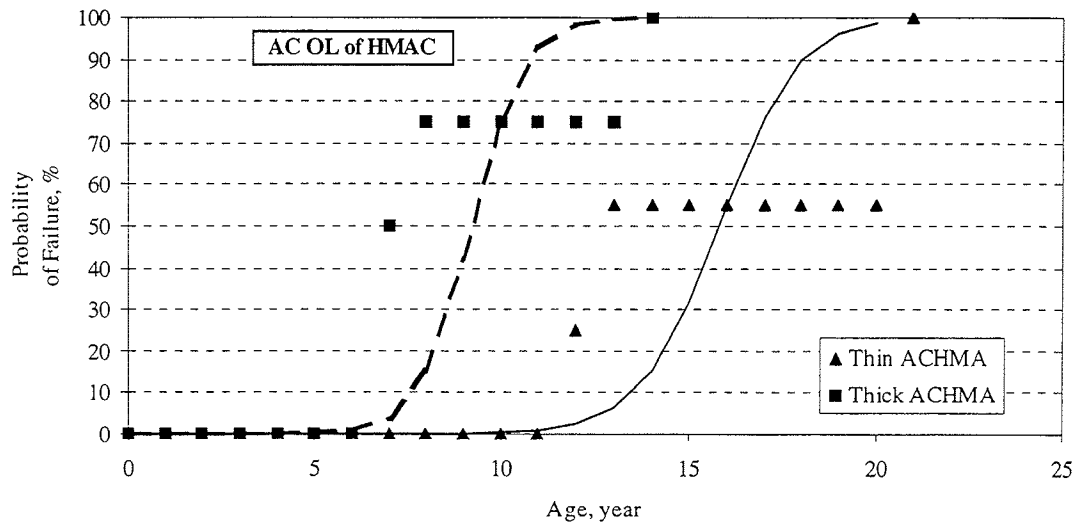
There are very few projects included here, so these results should be considered as very tentative. However, the results show a dramatic difference in survival between the thick and thin AC overlays and not in the direction expected (e.g., thin has longer life). This seemingly illogical result may be the result of placement of a thick overlay on an existing HMAC pavement that is in very poor condition causing a reduction of life of the thicker AC overlay. This result is similar to that found for thin and thick overlays of CRCP.

Table 10. Analysis summary and probability of failure model for first AC overlay over HMAC.

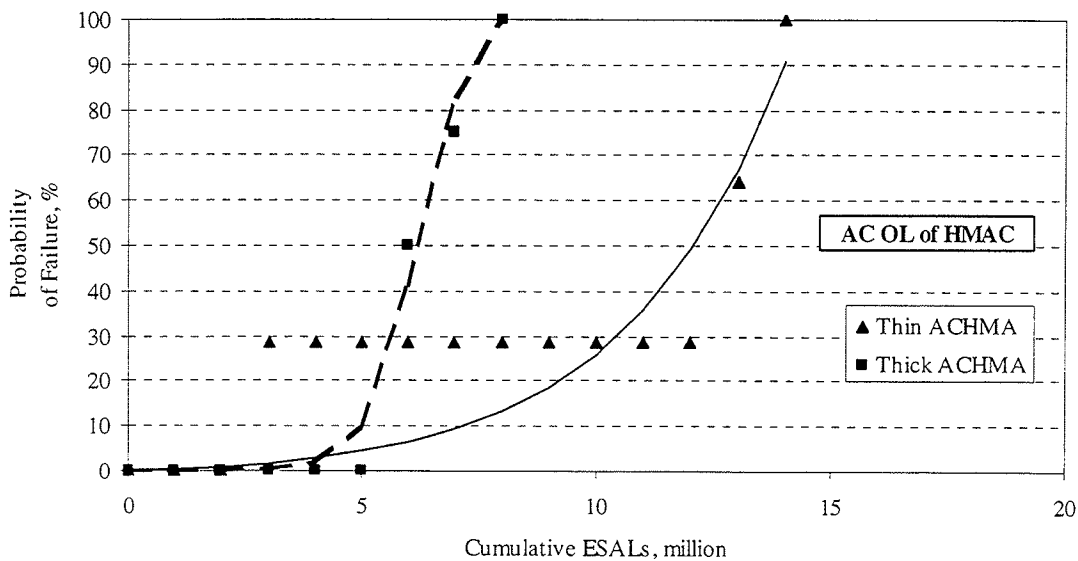
Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
Thin AC over HMAC	4**	75	14.5 (10)	15.5 (12)	17 (13.5)	-100.69 (-1155.90)	0.96 (0.32)	15.81 (21.63)	100.69 (1154.79)	21	14
Thick AC over HMAC	4**	100	8.5 (5.5)	9 (6)	10 (6.5)	-100.11 (-104.25)	1.42 (1.79)	9.23 (6.24)	100.11 (104.25)	14	8

* The models should not be used beyond these boundaries.

** Results are tentative due to limited number of sections.



A. Age survival curves



B. ESAL survival curves

Figure 12. Age and ESAL survival curves for first AC overlay over HMAC.

SURVIVAL OF SECOND AC OVERLAYS

Six AC overlay/pavement combinations were analyzed in the second overlay survival analysis: thin AC overlays of JRCP, thick AC overlays of JRCP, thin AC overlays of CRCP, thick AC overlays of CRCP, thin AC overlays of HMAC, and thick AC overlay of HMAC. For concrete pavements, within each category, sections without D-cracking and sections with D-cracking were analyzed separately. Thin AC overlays were defined as those less than 4 inches, and thick AC overlays were defined as those 4 inches or more.

Performance of Second AC Overlays of JRCP

These AC overlays are placed over 10-inch JRCP that have already been overlaid once. The thin AC overlays have an average thickness of 2.8 inches (ranges between 1.5 and 3.8 inches). The thick AC overlays have an average thickness of 5.1 inches (ranges between 4.0 and 7.0 inches). The age and ESAL survival curves for these AC overlays over JRCP with and without D-cracking are shown in Figure 13. Table 11 summarizes the data used in this analysis and the probability of failure model for this overlay design.

Examination of these survival curves does not show any strong trends or findings between thin and thick second AC overlays or between D-cracked JRCP and non-D-cracked JRCP. It does show that many sections of the thin overlay of JRCP carried a lot more traffic than a thick overlay of JRCP, similar to overlays of CRCP and HMA pavements. Compared to first AC overlays, the longevity and traffic carried are as follows at the 50th percentile level.

- Thin AC overlay of JRCP without D-Cracking: first overlay lasted 36 percent longer but the second overlay carried 45 percent more ESALs.
- Thick AC overlay of JRCP without D-cracking: first overlay lasted 25 percent longer but the second overlay carried 16 percent more ESALs.

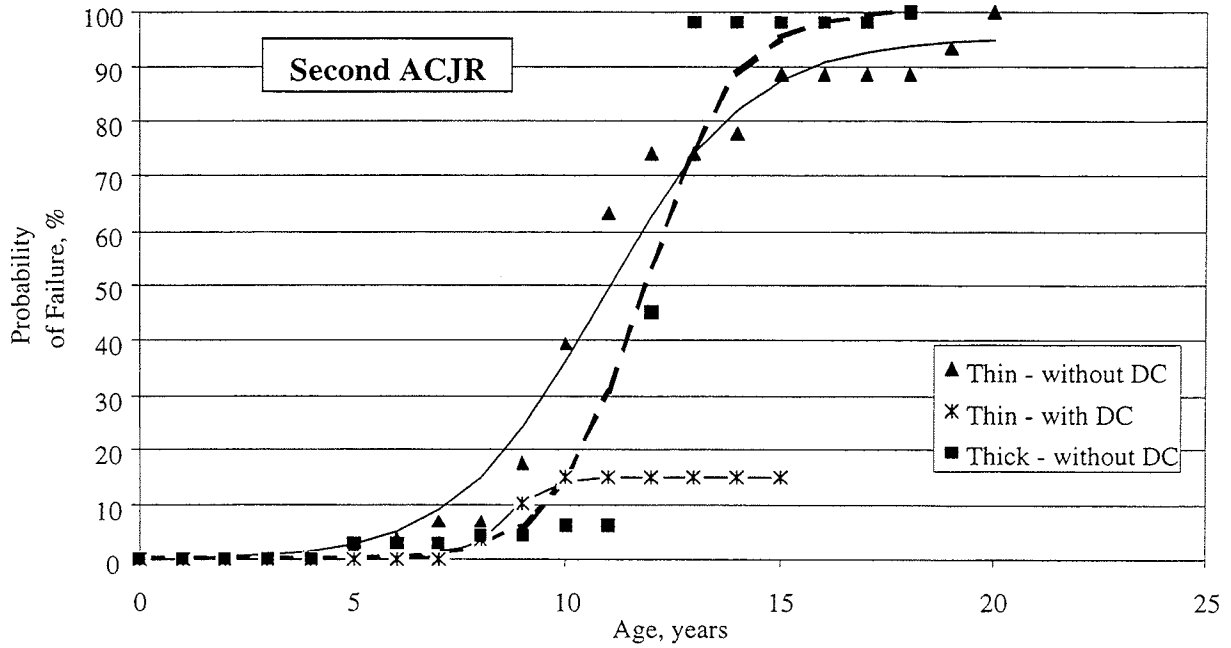
Thus, the first overlay lasted longer than the second overlay in years but carried fewer traffic loads. This reflects the large increase in traffic over time carried by second overlays.

Recent investigations of first and second-generation overlays have uncovered a durability problem known as stripping. HMA that becomes stripped has a reduction in stability that shortens the life of the overlay. Some second-generation overlays have had significant reductions in life due to stripping in the first generation overlays that were left in place. This indicates a need to evaluate the existing overlay to determine if any stripping has occurred, and if so, taking appropriate actions including removal if necessary.

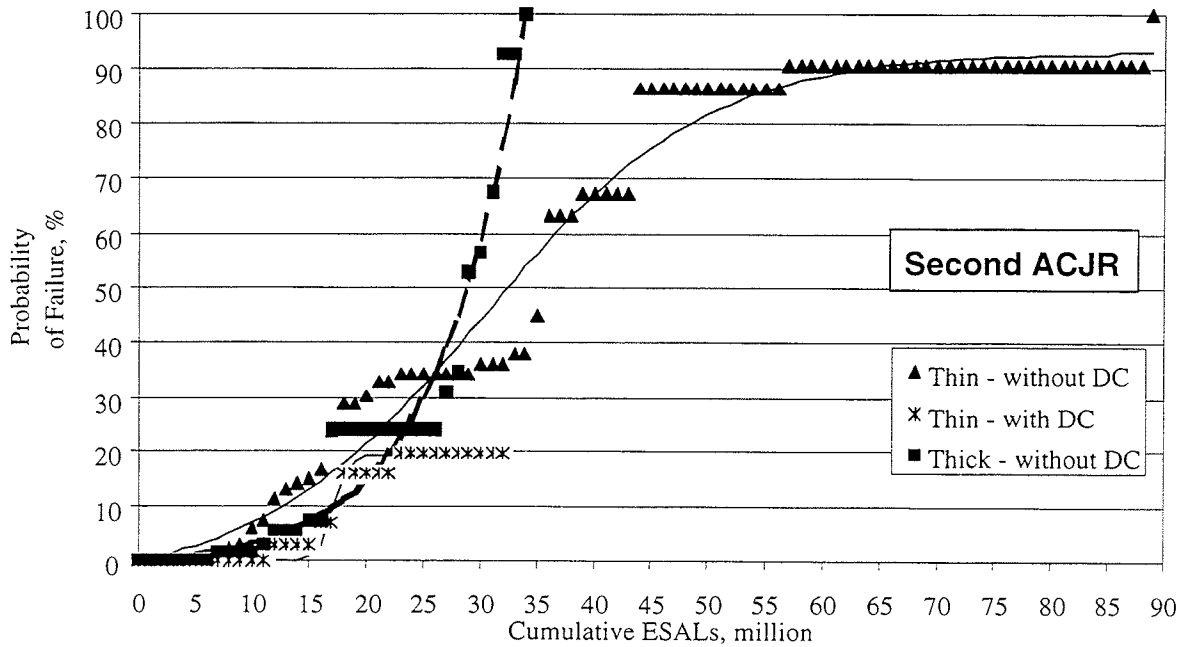
Table 11. Analysis summary for second AC overlay of JRCP.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
Thin ACJR - without DC	169	41	9 (22)	11 (32)	13 (45)	-95.65 (-97.70)	0.58 (0.10)	10.86 (30.05)	95.48 (93.25)	20	89
Thin ACJR - with DC	128	7	NA	NA	NA	-15.01 (-19.40)	2.13 (1.55)	8.59 (17.12)	15.01 (19.40)	15	32
Thick ACJR - without DC	71	80	11 (24)	12 (29)	13 (32)	-100.31 (-5182.38)	0.94 (0.13)	11.87 (63.50)	100.30 (5181.26)	18	34
Thick ACJR - with DC	2	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 13. Age and ESAL survival curves for second ACJR.

Performance of Second AC Overlays of CRCP

These AC overlays are placed over 7- to 10-inch CRCP that have already been overlaid once. The thin AC overlays have an average thickness of 3.1 inches (ranges between 1.5 and 3.5 inches). The thick AC overlays have an average thickness of 5.1 inches (ranges between 4.3 and 5.8 inches). The age and ESAL survival curves for these overlays over JRCP with and without D-cracking are shown in Figure 14. Table 12 summarizes the data used in this analysis and the probability of failure model for this overlay design.

Only limited data are available for these second AC overlays of CRCP since few have failed. Comparison of second thin AC overlays of non D-cracked JRCP and CRCP shows that there is no significant difference in life and JRCP carries 16 percent more ESALs.

- Thin second AC overlays of JRCP: 11 years, 32 million ESALs.
- Thin second AC overlays of CRCP: 10.5 years, 27.5 million ESALs.

Comparison of first and second-generation thin AC overlays of CRCP shows that the first-generation overlay has 14 percent longer life and 24 percent more ESALs.

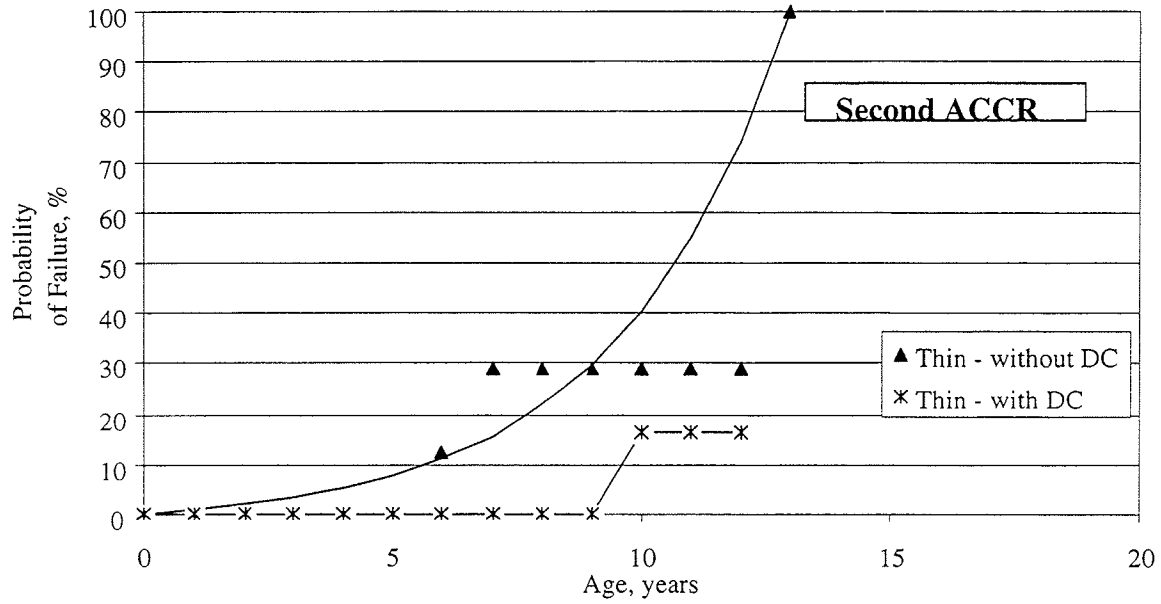
- First-generation thin AC overlay of CRCP: 12 years, 34 million ESALs
- Second-generation thin AC overlay of CRCP: 10.5 years, 27.5 million ESALs

Recent investigations of first and second-generation overlays have uncovered a durability problem known as stripping. HMAC that becomes stripped has a reduction in stability that shortens the life of the overlay. Some second-generation overlays have had significant reductions in life due to stripping in the first generation overlays that were left in place. This indicates a need to evaluate the existing overlay to determine if any stripping has occurred, and if so, taking appropriate actions including removal if necessary.

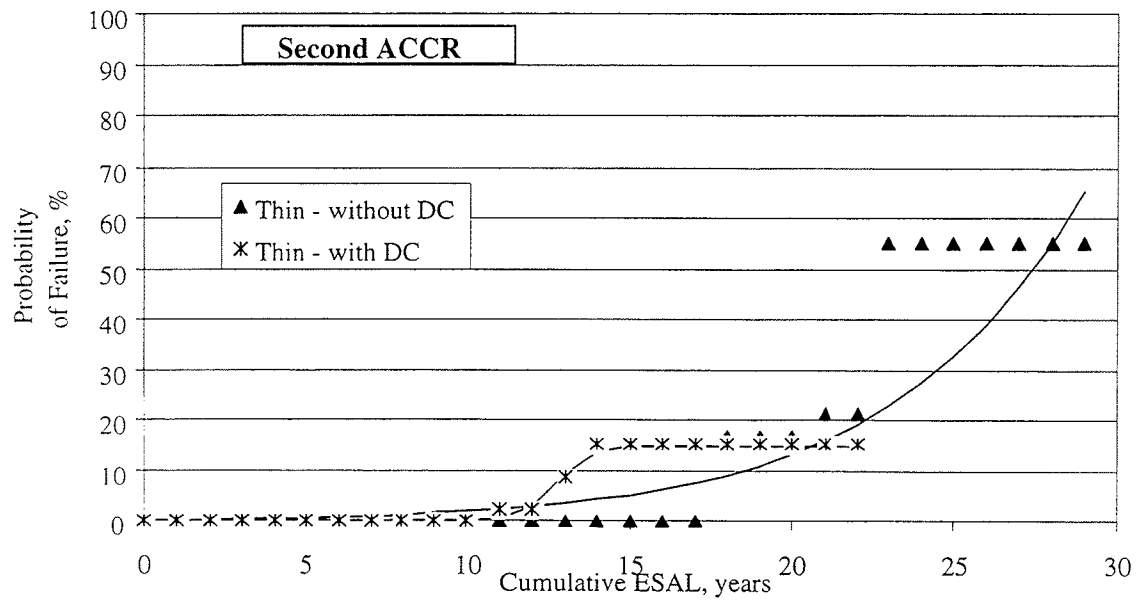
Table 12. Analysis summary and probability of failure model for second ACCR.

Category	No. of Sections	Percent Failed	Failure Percentile: Age, year (ESAL, million)			Model Coefficients: Age coefficient (ESAL coefficient)				Model Upper Boundary *	
			25	50	75	a	b	c	d	Age, year	ESALs, million
Thin ACCR - without DC	50	24	8.5 (23.5)	10.5 (27.5)	12 NA	-8402.97 (-1037.97)	0.29 (0.18)	28.04 (43.99)	8400.65 (1037.59)	13	29
Thin ACCR - with DC	125	4	NA	NA	NA	NA	NA	NA	NA	12	22
Thick ACCR - without DC	9	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thick ACCR - with DC	16	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

* The models should not be used beyond these boundaries.



A. Age survival curves



B. ESAL survival curves

Figure 14. Age and ESAL survival curves for second ACCR.

Performance of second AC Overlays of HMAC

These second AC overlays are placed over HMAC pavements that have been overlaid once and have an average thickness of 15.9 inches (ranges between 12.0 and 17.5 inches). The thin AC overlays have an average thickness of 2.7 inches (ranges between 2.0 and 3.3 inches). The thick AC overlays are 7.0 inches in thickness. There are only six thin second AC overlays over HMAC and none has failed to date; their ages range between 1 and 16 years and cumulative ESALs range between 1 and 31 million. There is only one thick second AC overlay over HMAC that lasted 8 years and carried 7 million ESALs.

When an overlaid pavement is being rehabilitated, the first overlay is often milled prior to placement of the second overlay. When too much thickness of the first overlay is removed, it may be unsound. If this happens, the thin lift of AC overlay that remains may become delaminated under the new AC overlay and reduce its life. Care must be taken that any remaining AC material must be sound before placing a new AC overlay.

SURVIVAL OF THIRD AC OVERLAYS

Table 13 shows the number of sections and range of age and cumulative ESALs of third AC overlays over JRCP, CRCP, and HMAC. Sufficient data were not available to complete a formal survival analysis for third AC overlays. In general, these overlays appear to be performing well given 136 sections and only 4 failures at 5 to 6 years. It appears that many of these are carrying very heavy traffic loadings.

Table 13. Summary of third AC overlay performance over JRCP, CRCP, and HMAC.

Overlay Category	No. of Sections	Percent Failed	Age range of failed sections	ESAL range of failed sections (millions)	Age range of in-service sections (years)	ESAL range of in-service sections (millions)
Third ACJR	136	4	5-6	15-32	2-13	3-74
Third ACCR	17	0	NA	NA	2-5	2-11
Third AC on HMAC	1	0	NA	NA	11	14

SUMMARY AND CONCLUSIONS

A survival analysis has been conducted that includes nearly all sections of the Illinois Interstate and other freeway type pavements. These original pavements include HMAC, JRCP, and CRCP. Survival analyses of first, second, and third AC overlays of these original pavements are also included. Many significant results were obtained relative to the longevity (age) and load carrying capacity (ESALs carried) of these original pavements and overlays that will provide information needed to improve programming, design, construction, and rehabilitation. The report also provides models for predicting the probability of failure for various designs of original pavements and asphalt concrete (AC) overlays in Illinois that are useful for pavement management purposes.

LONGEVITY OF ILLINOIS FREEWAY PAVEMENTS

Survival analysis results illustrate that over 90 percent of the original JRCP and CRCP carried far more load applications than they were designed to carry. Thus, these pavements have performed as expected. The 50th percentile longevity of the JRCP and different CRCP designs were nearly all greater than 20 years including even those with D-cracking. Some of these pavements did not last the full 20-year design life because truck traffic loadings have increased far in excess of what was expected over their design life. Table 14 provides a summary of the 50th percentile values for pavements without D-cracking.

Table 14. Summary of longevity and load carrying capacity of Illinois Interstate and other freeway pavements (non D-Cracked).

Pavement Type	50 th Percentile Life at Overlay	50 th Percentile ESALs at Overlay	Design ESALs
10-inch JRCP	21 years	15 million	5 million
7-inch CRCP	26	23	2
8-inch CRCP	27	18	5
9.-inch CRCP	27	28	10
10-inch CRCP	23	40-90	21
HMAC	16	7.5	Varies

It is important to continue to identify the causes of early rehabilitation so that appropriate improvements in design, construction, and materials can be made in a timely manner so that pavements built in the future will benefit from this knowledge. In fact, the continual increase in truck traffic on the Illinois freeway pavements requires strong and continuing efforts to improve every facet of engineering and construction. Results from survival analyses have been found to be very useful to the Illinois DOT managers and engineers in making improvements over the years.

JRCP and CRCP

Results for the original JRCP design (built between 1955 and 1970) showed the negative effect of D-cracking in the southern region where the 50th percentile load carrying capacity (ESALs) for sections without D-cracking is 30 percent more than that for

sections with D-cracking (18.5 million ESALs versus 14 million ESALs). There is a new design of jointed plain concrete pavements that should overcome the weaknesses of this old design and provide improved performance. However, based upon pavement selection procedures, few of these pavements will be constructed on the Interstate system.

Results show that D-cracking had a large effect on the performance (in terms of age and ESALs carried) of 7, 8, and 9-inch CRCP in both north and south regions. Non D-cracked CRCP carried from 32 to 63 percent more ESALs. IDOT has taken strong action to prevent the use of aggregates that are susceptible to D-cracking over the past several decades, which will benefit future performance.

Comparisons between the various concrete pavement designs are illustrated in Table 15. A 10-inch JRCP was roughly equivalent to a 7- or 8-inch CRCP in longevity and traffic carrying capacity in the same region of Illinois confirming the 0.8 thickness reduction for CRCP (i.e., CRCP thickness is 80% of JRCP thickness for the same project conditions).

Table 15. Comparison of concrete pavement survival.

Design	Northern Region		Southern Region	
	50 th Percentile Age, years	50 th Percentile ESALs, million	50 th Percentile Age, years	50 th Percentile ESALs, million
10-inch JRCP	10	17.5	25.5	18.5
7-inch CRCP	12	23.5	29.5	35
8-inch CRCP	15	22	32.5	22
9-inch CRCP	34.5	28	27	23
10-inch CRCP	90	23	NA	NA

Thickness of CRCP has a dramatic effect on traffic load carrying capacity. These results tend to indicate that the design thicknesses for these sections were reasonable to produce a similar life. With the increased traffic loadings, all recent CRCP have been designed greater than 10 inches. This is a prudent step because truck traffic levels continue to increase over time.

The performance of JRCP and CRCP varied between northern and southern regions quite significantly for some designs. For JRCP as well as 7- and 8-inch CRCP, the results showed that pavements in the south carried more traffic and exhibited longer life. For example, for 8-inch CRCP without D-cracking, the 50th percentile life in the north was 22 years and the south was 32.5 years. The ESALs carried were 15 million in the north versus 22 million in the south at the 50th percentile. These results show a 40 to 50 percent increase in life and traffic carried in the south versus the north. The main reason could be the harsher climate that exists in the northern portion of Illinois (increased use of deicing salts, depth of frost penetration, more pavement freeze-thaw cycles).

HMAC

There are fewer HMAC pavements on the Interstate or other freeways and many of these have not reached their first overlay. Thus, these results should be considered as tentative

until more sections reach their first or second rehabilitation. For HMAC located in the north region, the age at 50th percentile is 16 years and ESALs are 7.5 million for the northern region. Data were inadequate to determine any survival for the southern region due to the younger age (3 to 14 years and 2 to 16 million ESALs) of these pavements. Future survival analyses will more adequately model the longevity of these HMAC pavements.

There have been many improvements to HMAC design, materials, and construction practices, which should increase their longevity. The designs include improved subgrades, and full-depth, full quality bituminous layers. New materials include PG graded asphalts, polymers, and aggregate blends. Construction methods include new rubber-tired rollers, material transfer devices, and end-result specifications.

General Longevity and Load Carrying Capacity of AC Overlays

Table 16 provides a summary of the 50th percentile values for AC overlays over JRCP and CRCP with and without D-cracking as well as over HMAC. The longevity and load carrying capacity are shown for both first and second AC overlays.

Table 16. Summary of longevity and load carrying capacity of AC overlays of Illinois Interstate and other freeway pavements.

Overlay Design	Existing Pavement	50 th Percentile Age, years		50 th Percentile ESALs, million	
		With DC	Without DC	With DC	Without DC
Thin AC Overlay	JRCP	First OL: 12 Second OL: NA	15 11	15 NA	22 32
	CRCP	First OL: 12 Second: NA	13 10.5	22 NA	34 27.5
	HMAC	First OL: 15.5 Second OL: NA		12 NA	
Thick AC Overlay	JRCP (Poor Condition)	First OL: 11 Second OL: NA	15 12	13 NA	25 29
	CRCP (Poor Condition)	First: 13 Second: NA	15 NA	10 NA	21 NA
	HMAC (Poor Condition)	First OL: 8.5 Second OL: NA		6 NA	

First/Second OL: Refers to first AC overlay and second AC overlay
 NA: Data not available

AC Overlays—D-Cracking of Existing Pavement

The most dramatic result is the negative impact of D-cracking of the underlying JRCP or CRCP on performance. For first thin AC overlays of JRCP, the median ESALs carried were 15 million for D-cracked JRCP versus 22 million for non-D-cracked JRCP (47 percent more). For thick AC overlays, the difference was 13 million versus 25 million ESALs (92 percent more). The longevity was also lower for the original D-cracked JRCP than non-D-cracked JRCP. Thus, the damaging effects of non-durable aggregates continue after the original pavement is overlaid.

AC overlays of CRCP showed similar results for the negative impact of D-cracking. For thin AC overlays, the mean ESALs carried were 22 million for D-cracked CRCP versus 34 million (55 percent more) for non-D-cracked CRCP. For thick AC overlays, the difference was 10.5 million versus 21 million ESALs (100 percent more).

Thin AC Overlays—JRCP versus CRCP

The thin AC overlays over CRCP carried 54 percent more traffic than over JRCP that is due to reduced reflection cracking from transverse joints and deteriorated cracks and repairs in JRCP. For example, a thin AC overlay on CRCP without D-cracking performed amazingly well carrying 34 million ESALs at the 50th percentile. This supports what is generally believed in Illinois that when a CRCP (that is not in very poor condition) is overlaid even with a relatively thin AC overlay, its performance is typically outstanding.

Thick AC Overlays/Poor Pre-Overlay Pavement Condition—JRCP, CRCP, and HMAC

In contrast, the thick AC overlays show approximately the same performance over CRCP and JRCP. This is because the thicker AC overlays are placed only on badly deteriorated CRCP or JRCP, and thus the condition of the existing pavement prior to overlay appears to be more important than pavement type on future performance.

Comparisons of the effect of the combination of thicker AC overlays and poorer condition of the existing pavements are shown in Table 17. This data indicates the following:

- JRCP: A thick overlay placed over a JRCP in very poor condition results in similar load carrying capacity than when a thin overlay was placed over a JRCP in better condition (thin and thick both carried about 19 million ESALs on average until a second overlay was placed).
- CRCP: A thick overlay placed over a CRCP in very poor condition results in much lower load carrying capacity than when a thin overlay was placed over a CRCP in better condition (16 versus 28 million ESALs).
- HMAC: A thick overlay placed over a HMAC in very poor condition results in much lower load carrying capacity than when a thin overlay was placed over a HMAC in better condition (6 million versus 12 million ESALs).

Table 17. Data showing the load carrying capacity (50th percentile) of thin and thick AC overlays.

AC Overlay*	Existing JRCP	Existing CRCP	Existing HMAC
First Thin Overlay	19 million ESALs	28 million ESALs	12 million ESALs
First Thick Overlay (increased deterioration of existing pavement)	19 million ESALs	16 million ESALs	6 million ESALs

* Averaged for both D-cracked and non D-cracked pavements

This is a very important finding and points out the benefit of overlaying before an existing pavement is in very poor condition. The extra costs of a thicker overlay plus major reduction in traffic (ESALs) carried far outweighs the cost of placement of the overlay earlier before serious deterioration occurs.

First and Second-Generation AC Overlays

Comparison of first and second AC overlays showed the longevity of the first overlay was about 30 percent longer in years but the second overlay carried about 30 percent more ESALs.

Some second-generation overlays have had significant reductions in life due to stripping in the first generation overlays that were left in place. This indicates a need to evaluate the existing overlay to determine if any stripping has occurred, and if so, taking appropriate action including removal if necessary.

REFERENCES

1. Dwiggins, M. E., J. P. Hall, M. I. Darter, C. L. Flowers, and J. B. DuBose, "Pavement Performance Analysis of the Illinois Interstate Highway System," University of Illinois and Illinois Department of Transportation, Report No. FHWA-IL-UI-220, 1989.
2. Hall, K.T., M. I. Darter, and W. Max Rexroad, "Performance of Bare and Resurfaced JRCP and CRCP on the Illinois Interstate Highway System - 1991 Update" Illinois Cooperative Highway Research Report No. 532-1, University of Illinois and Illinois Department of Transportation, Report No. FHWA-IL-UI-244, 1993.
3. Gharaibeh, N.G., M. I. Darter, F. LaTorre, J.W. Vespa, and D.L. Lippert, "Performance of Original and Resurfaced Pavements on the Illinois Freeway System" Illinois Cooperative Highway Research Report No. 540-1, University of Illinois and Illinois Department of Transportation, UILU-ENG-96-2010, 1997.

APPENDIX A: DATABASE

ROUTE (RTE), DIRECTION (DIR), BEGINNING, ENDING MILEPOSTS (BMP, EMP), and DISTRICT (DIST)

These section identification and milepost limit data were retrieved from the IPFS database. A total of 1508 sections are listed in the database; however, 1402 sections are used in the analysis. The IPFS database does not include the Illinois Toll Roads.

YEAR OF CONSTRUCTION (YEAR)

Year of original construction data were retrieved from the IPFS database. The original construction years in the IPFS database may be in many cases the year that the contract was 100 percent completed (including all work on guardrails, seeding, etc.). It is possible that in these cases, the pavements may actually have been opened to traffic as much as a year earlier. As a result, the current age and accumulated ESALs may be underestimated for these pavements. However, since the reported year of construction may be closer to the actual opening date for other sections, to arbitrarily add a year of age and traffic to all sections in the database would overestimate the age and traffic of some other pavements.

D CRACKING (DC)

D cracking indicator for many sections is missing (DC = 0). These sections were excluded from the analysis. D cracking status is assumed valid for all other sections (DC = Y or DC = N)

PAVEMENT TYPE (TYPE)

The following pavement type labels were used for the pavement types identified in the IPFS database:

Label	Description
JRCP	Jointed Reinforced Concrete Pavement
CRCP	Continuously Reinforced Concrete Pavement
BRID	BRIDGE
HMAC	Full-depth Asphalt
UNKN	Unknown
ACJR	AC-Overlaid JRCP
ACCR	AC-Overlaid CRCP

ORIGINAL PAVEMENT THICKNESS (THK0)

Original pavement thickness was retrieved from the IPFS database.

OVERLAY YEAR OF CONSTRUCTION, TYPE, AND THICKNESS (YEAR1, REH1, THK1, ETC.)

The construction year (YEAR), type (REH), and thickness (THK), for first, second, third, and fourth overlays were retrieved from the IPFS database. The overlays are listed in chronological order: YEAR1, REH1, and THK1 are for the first overlay; YEAR2, REH2, THK2 are for the second overlay; YEAR3, REH3, and THK3 are for the third overlay; and YEAR4, REH4, and THK4 are for the fourth overlay. The rehabilitation type "3" represents a thin AC overlay (less than 4 inches), while the rehabilitation type "5" represents a thick AC overlay (4 inches or more).

ACCUMULATED ESALs FROM CONSTRUCTION TO FIRST OVERLAY OR 2001 (E0)

Annual ESALs for each year from construction to 2001 were retrieved for each section from the IPFS database. These data were used to compute the accumulated ESALs from year of construction to year of first overlay, or to 2001 for sections without an overlay.

AGE OF ORIGINAL PAVEMENT AT YEAR OF FIRST OVERLAY OR IN 2001 (N0)

The age of each section when first overlaid or in 2001 was computed by subtracting YEAR from YEAR1 for overlaid sections, and subtracting YEAR from 2001 for sections without overlays.

ACCUMULATED ESALs BETWEEN OVERLAYS (E1, E2, E3, E4)

These data are the accumulated ESALs from year of first overlay to year of second overlay, or to 2001 (E1) and from year of second overlay to year of third overlay, or to 2001 (E2), etc.

AGE OF OVERLAYS (N1, N2, N3, N4)

The age of each overlaid section when overlaid for the second time or in 2001 (N1) was computed by subtracting YEAR1 from YEAR2; the age of each overlaid section when overlaid for the third time or in 2001 (N2) was computed by subtracting YEAR2 from YEAR3; etc.

CODE

This code indicates questionable sections that were excluded from the analysis. Reasons for exclusion include the following:

- 1 = Life of original pavement is less than 5 years or greater than 35
- 2 = Life of 1st OL is less than 4 years or greater than 20 years
- 3 = Life of 2nd OL is less than 4 years or greater than 20 years

- 4 = Life of 3rd OL is less than 4 years or greater than 20 years
- 5 = Life of 4th OL is less than 4 years or greater than 20 years
- 6 = Data could not be verified
- 7 = Bridge section

CRS88, CRS90, CRS92, etc

These columns contain the CRS values in 1988, 1990, 1992, 1994, 1996, and 1998. For example, CRS98 is the CRS value in 1998.

RTE	DIR	BMP	EMP	DIST	YEAR	DC	TYPE	THK0	YEAR1	REH1	THK1	YEAR2	REH2	THK2	YEAR3	REH3	THK3	YEAR4	REH4	THK4	E0	N0	E1	N1	E2	N2	E3	N3	E4	N4	CODE	CRS88	CRS90	CRS92	CRS94	CRS86	CRS98	
55	N	138.01	141.53	6	1978	N	JRCP	9	2000	5	4.25	0	0	0	0	0	0	0	0	0	19.45	22	1.282	1	0	0	0	0	0	0	7.7	7.5	7.5	6.3	6.2	6.1		
55	N	141.53	145.24	3	1978	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	0	20.24	23	0	0	0	0	0	0	0	0	7.6	7.4	7.2	6.8	6.2	5.8	
55	N	145.24	151.04	3	1978	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	0	24.32	23	0	0	0	0	0	0	0	0	7.5	7.4	7.2	6.8	6.1	5.7	
55	N	151.04	156.42	3	1978	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	0	24.32	23	0	0	0	0	0	0	0	0	7.5	7.4	7.2	6.8	6.1	5.7	
55	N	156.42	157.15	3	1967	Y	JRCP	10	1982	3	3	1992	3	3.25	0	0	0	0	0	0	0	4.44	15	9.141	10	28.89	9	0	0	0	0	6.3	9	8.5	7.4	7.2		
55	N	157.15	158.23	3	1967	Y	JRCP	10	1982	5	4.5	1992	3	3.25	0	0	0	0	0	0	0	15.26	4	0	0	0	0	0	0	0	0	6.3	9	8.5	7.4	7.2		
55	N	158.23	159.36	3	1965	Y	JRCP	10	1982	5	4.5	1992	3	3.25	0	0	0	0	0	0	0	10.73	17	13.18	10	30.08	9	0	0	0	0	6.3	9	8.5	7.4	7.2		
55	N	159.36	161.32	3	1965	Y	JRCP	10	1982	5	4.5	1992	3	3.25	0	0	0	0	0	0	0	14.90	17	16.46	10	30.44	9	0	0	0	0	6.3	9	8.5	7.4	7.2		
55	N	161.32	162.42	3	1969	N	JRCP	13.3	0	0	0	0	0	0	0	0	0	0	0	0	7.86	2	0	0	0	0	0	0	0	0	6.3	9	8.5	7.3	7			
55	N	162.42	162.75	3	1964	Y	JRCP	10	1982	5	4.5	1992	3	3.25	0	0	0	0	0	0	0	15.16	18	16.46	10	30.44	9	0	0	0	0	6.3	9	8.5	7.3	7		
55	N	162.75	163.34	3	1964	Y	JRCP	10	1982	5	4.5	1991	3	3.25	0	0	0	0	0	0	0	15.16	18	14.43	9	32.47	10	0	0	0	0	6.3	9	8.5	7.4	6.7		
55	N	163.34	164.10	3	1964	Y	JRCP	10	1982	5	4	1991	3	3.25	0	0	0	0	0	0	0	11.08	18	10.21	9	27.37	10	0	0	0	0	6.3	9	8.5	7.4	6.7		
55	N	164.10	167.93	3	1964	Y	JRCP	10	1982	5	4	1993	3	1.5	0	0	0	0	0	0	0	10.57	11	11.57	11	11.64	8	0	0	0	0	6.3	9	8.5	7.4	6.7		
55	N	167.93	169.85	3	1975	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	25.59	23	0	0	0	0	0	0	0	0	7	6.7	6.2	6	5.3	6		
55	N	169.85	173.54	3	1975	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	26.27	26	0	0	0	0	0	0	0	0	7	7.3	7.2	6.6	6	5.3		
55	N	173.54	176.36	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	25.15	23	0	0	0	0	0	0	0	0	7	6.4	6	5.7	5.1	4.9		
55	N	176.36	180.77	3	1976	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	24.86	25	0	0	0	0	0	0	0	0	7	6.9	6	6.3	6.1	5.6		
55	N	180.77	185.13	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.83	23	0	0	0	0	0	0	0	0	7	6.9	6	6.3	6.2	5.7		
55	N	185.13	187.85	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.83	23	0	0	0	0	0	0	0	0	7	6.9	6	6.3	6.2	5.7		
55	N	187.85	194.97	3	1979	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.83	23	0	0	0	0	0	0	0	0	7	6.9	6	6.3	6.2	5.7		
55	N	194.97	201.11	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.31	22	0	0	0	0	0	0	0	0	7.3	7.3	7.1	6.9	6.7	6.5		
55	N	201.11	204.69	3	1979	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.32	22	0	0	0	0	0	0	0	0	7.2	7.2	7.2	6.6	6.5	6.2		
55	N	204.69	207.65	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	23.92	22	0	0	0	0	0	0	0	0	7.2	7.2	7.2	6.6	6.5	6.2		
55	N	207.65	211.54	3	1974	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	26.96	27	0	0	0	0	0	0	0	0	7	6.8	6.7	5.8	5.9	5.2		
55	N	211.54	215.55	3	1978	Y	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	25.81	23	0	0	0	0	0	0	0	0	7	6.8	6.7	5.8	5.9	5.2		
55	N	215.55	221.21	3	1981	N	JRCP	10	0	0	0	0	0	0	0	0	0	0	0	0	23.92	20	0	0	0	0	0	0	0	0	7.4	7.6	7.5	7.9	7.4	7.3		
55	N	221.21	226.63	3	1979	N	JRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	27.18	22	0	0	0	0	0	0	0	0	7.7	7.4	7.3	7.1	7.3	7.2		
55	N	226.63	233.65	3	1978	N	JRCP	10	1978	5	5.25	1991	3	1.75	1999	3	3.5	0	0	0	0	0.56	22	12.68	13	11.95	8	3.498	2	0	0	5.7	5	8.1	7.4	6.4	5.7	
55	N	233.65	238.97	1	1957	N	JRCP	10	1974	5	4.5	1990	3	3.25	1999	3	3.5	0	0	0	0	7.25	17	15.82	16	13.25	9	3.506	2	0	0	5.1	9	7.8	6	5.4	4.6	
55	N	238.97	241.81	1	1937	0	JRCP	7	1952	3	3	1999	3	3.3	1999	3	3.3	0	0	0	3.5	0.00	15	5.796	17	18.34	21	16.54	9	4.83	2	3	5.1	9	7.8	6	5.4	4.6
55	N	241.81	242.31	1	1937	0	JRCP	7	1952	3	3	1999	3	3.25	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	242.31	243.06	1	1961	N	JRCP	10	1969	3	3	1990	3	3.25	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	243.06	245.14	1	1937	0	ACJR	11	1969	3	3	1969	3	3.3	1999	3	3.3	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	245.14	246.25	1	1958	0	JRCP	7	1968	5	9.8	1979	3	3	1990	3	3.3	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	246.25	247.79	1	1937	0	JRCP	7	1968	5	9.8	1976	3	3	1990	3	3.3	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	247.79	248.15	1	1957	N	JRCP	10	1990	3	3.25	1999	3	3.5	0	0	0	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	248.15	248.60	1	1957	N	JRCP	10	1990	3	3.25	1999	3	3.5	0	0	0	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	248.60	248.82	1	1933	0	JRCP	10	1969	3	3	1990	3	3.3	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	248.82	249.03	1	1957	N	JRCP	10	1969	3	3	1990	3	3.3	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	249.03	249.20	1	1933	0	JRCP	10	1969	3	3	1990	3	3.3	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	249.20	249.90	1	1963	N	JRCP	10	1969	3	3	1990	3	3.3	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	249.90	250.84	1	1933	0	JRCP	10	1969	3	3	1990	3	3.3	1999	3	3.5	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	250.84	251.52	1	1933	0	JRCP	7	1968	5	9.8	1976	3	3	1990	3	3.3	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.83	2	3	4.6	9	7.8	6	5.4	4.6
55	N	251.52	251.95	1	1957	N	JRCP	10	1990	3	3.25	1999	3	3.5	0	0	0	0	0	0	3.5	0.00	15	5.581	17	18.66	21	14.06	9	3.								

RTE	DIR	BMP	EMP	DIST	YEAR	DC	TYPE	THK0	YEAR1	REH1	THK1	YEAR2	REH2	THK2	YEAR3	REH3	THK3	YEAR4	REH4	THK4	E0	NO	E1	N1	E2	N2	E3	N3	E4	N4	CODE	CRS88	CRS90	CRS92	CRS94	CRS96	CRS98		
55	S	6.69	8.20	8	1962	Y	JRCP	10	1990	3	3.25	0	0	0	0	0	0	0	0	0	20.19	28	15.53	11	0	0	0	0	0	0	52	9	8.5	8	6.4	5.9			
55	S	8.20	9.20	8	1962	Y	JRCP	10	1986	3	3	1998	3	3.25	0	0	0	0	0	0	0	14.59	24	16.27	12	4.861	3	0	0	0	0	5.2	9	8.5	8	6.4	5.9		
55	S	9.20	10.61	8	1961	N	JRCP	10	1986	3	3	1998	3	3.25	0	0	0	0	0	0	0	16.68	25	18.74	12	4.901	3	0	0	0	0	6.9	6.9	6.6	6.4	5.1	9		
55	S	10.61	10.75	8	1961	N	JRCP	10	1986	3	3	1995	0	0	0	0	0	0	0	0	0	16.68	25	16.21	9	12.19	6	0	0	0	0	7.6	6.9	6.6	6.4	7.9	8.1		
55	S	11.07	11.07	8	1961	N	JRCP	10	1985	3	3.25	0	0	0	0	0	0	0	0	0	0	32.89	34	12.19	6	0	0	0	0	0	0	0	0	6.8	6.6	6	6.4	7.9	8.1
55	S	11.07	11.97	8	1961	N	JRCP	10	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	32.89	34	12.19	11	12.19	6	0	0	0	0	0	6.8	6.6	6	6.4	7.9	8.1	
55	S	14.30	15.01	8	1960	N	JRCP	10	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	15.56	24	18.57	11	11.95	6	0	0	0	0	6.8	6.6	6	6.4	7.9	8.1		
55	S	15.01	15.92	8	1960	N	JRCP	10	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	16.21	24	18.08	11	13.05	6	0	0	0	0	6.8	6.6	6	6.4	7.9	8.1		
55	S	15.92	16.40	8	1960	N	JRCP	10	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	34.29	35	13.05	6	0	0	0	0	0	0	9	6.6	6.6	9	7.9	8.1		
55	S	16.40	16.72	8	1975	N	CRCP	9	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	16.21	24	18.08	11	13.05	6	0	0	0	0	9	6.6	6.6	9	7.9	8.1		
55	S	16.72	17.12	8	1975	N	CRCP	9	1984	3	3	1995	3	3.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
55	S	17.12	18.38	8	1956	N	JRCP	10	1984	3	3	1983	3	3.25	0	0	0	0	0	0	0	43.08	26	0	0	0	0	0	0	0	0	6.6	6.6	6.4	9	8.5	9		
55	S	18.38	20.01	8	1956	N	JRCP	10	1984	3	3	1983	3	3.25	0	0	0	0	0	0	0	16.02	28	15.26	9	18.28	8	0	0	0	0	6.6	6.3	5.9	8.8	7.4	7.5		
55	S	20.01	20.84	8	1956	N	JRCP	10	1976	3	3	1983	3	3.25	0	0	0	0	0	0	0	16.02	28	15.26	9	18.28	8	0	0	0	0	6.6	6.3	5.9	8.8	7.4	7.5		
55	S	20.84	21.59	8	1956	N	JRCP	10	1976	3	3	1984	3	3	1994	3	3	1994	3	3	3	0	0	0	0	0	10.98	7	0	0	0	6.6	6.3	5.9	8.8	7.4	7.5		
55	S	21.59	22.18	8	1956	N	JRCP	10	1998	3	3	1987	3	3.25	0	0	0	0	0	0	0	24.41	20	7.783	3	0	0	0	0	0	0	6.9	6.9	6.9	6.5	5.7	9		
55	S	22.18	22.42	8	1978	N	JRCP	10	1976	3	3	1987	5	4.3	1998	3	3.25	0	0	0	0	0	24.41	20	7.783	3	0	0	0	0	0	0	6.9	6.9	6.9	6.5	5.7	9	
55	S	22.42	22.74	8	1978	N	JRCP	10	1988	3	3	1987	5	4.3	1998	3	3.25	0	0	0	0	0	24.41	20	7.783	3	0	0	0	0	0	0	6.9	6.9	6.9	6.5	5.7	9	
55	S	22.74	23.11	8	1956	N	JRCP	10	1978	3	3	1987	3	3.25	0	0	0	0	0	0	0	4.94	20	9.192	11	16.44	11	5.923	3	0	0	0	6.8	6.5	6.3	6	5.8	9	
55	S	23.11	29.38	8	1956	N	JRCP	10	1978	3	3	1987	3	3.25	0	0	0	0	0	0	0	4.94	20	9.192	11	16.44	11	5.923	3	0	0	0	6.8	6.5	6.3	6	5.8	9	
55	S	29.38	29.64	8	1956	N	JRCP	10	1978	3	3	1987	3	3.25	0	0	0	0	0	0	0	1.75	22	8.958	9	16.32	3	0	0	0	0	7.8	7.9	6.5	6.4	6	5.8	9	
55	S	29.64	29.90	8	1956	N	JRCP	10	1978	3	3	1987	3	3.25	0	0	0	0	0	0	0	1.69	22	8.724	11	16.19	11	5.822	3	0	0	0	7.9	6.5	6.4	6	5.8	9	
55	S	29.90	30.36	8	1956	N	JRCP	10	1998	3	3	1987	5	4.3	1998	3	3.25	0	0	0	0	1.69	22	8.724	9	16.19	11	5.722	3	0	0	0	7.9	6.5	6.4	6	5.8	9	
55	S	30.36	32.66	8	1956	N	JRCP	10	1978	3	3	1987	3	3.3	1998	3	3.25	0	0	0	0	23.77	22	7.52	3	0	0	0	0	0	0	6.7	6.7	6.4	6	5.8	9		
55	S	32.66	33.23	8	1956	N	JRCP	10	1987	3	3.3	1987	3	3.3	1998	3	3.25	0	0	0	0	1.93	22	8.985	9	16.37	11	5.131	3	0	0	0	7.9	6.5	6.4	6	5.8	9	
55	S	33.23	33.67	8	1978	N	JRCP	10	1998	3	3.25	0	0	0	0	0	0	0	0	0	0	9.61	31	16.37	11	5.131	3	0	0	0	0	7.9	6.5	6.4	6	5.8	9		
55	S	33.67	39.13	8	1978	N	JRCP	9	1991	3	3.25	0	0	0	0	0	0	0	0	0	0	24.05	20	5.131	3	0	0	0	0	0	0	7.9	6.5	6.4	6	5.8	9		
55	S	39.13	43.21	6	1974	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	0	0	14.40	16	15.42	3	0	0	0	0	0	0	6.8	5.7	6.6	6.6	5.8	9		
55	S	43.21	46.60	6	1974	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	0	0	22.48	21	6.853	4	0	0	0	0	0	0	6.8	5.7	6.6	6.6	5.8	9		
55	S	46.60	50.38	6	1974	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	0	0	23.40	23	7.025	4	0	0	0	0	0	0	7	6.5	6.3	5.7	9	7.8		
55	S	50.38	53.58	6	1974	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	0	0	23.40	23	7.025	4	0	0	0	0	0	0	7	6.5	6.3	5.7	9	7.8		
55	S	53.58	56.06	6	1974	Y	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	0	9.10	13	21.33	14	0	0	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5		
55	S	56.06	57.33	6	1974	Y	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	0	14.98	18	15.97	9	0	0	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5		
55	S	57.33	60.13	6	1974	Y	CRCP	9	1987	3	3	1992	3	3.25	0	0	0	0	0	0	0	0	14.98	18	15.97	9	0	0	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5	
55	S	60.13	61.08	6	1974	Y	CRCP	9	1987	3	3	1992	3	3.25	0	0	0	0	0	0	0	0	8.16	13	6.816	5	15.97	9	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5	
55	S	61.08	62.71	6	1973	Y	CRCP	9	1987	3	3	1992	3	3.25	0	0	0	0	0	0	0	0	9.10	13	6.044	5	15.5	9	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5	
55	S	62.71	63.18	6	1973	Y	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	0	0	9.10	13	6.044	5	15.5	9	0	0	0	0	8.7	8.4	7.2	7.5	7	7.5	
55	S	63.18	66.00	6	1973	Y	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	0	0	16.05	19	13.46	9	0	0	0	0	0	6.9	6.4	4.9	8.5	7.8	7.3		

Table with 50 columns (RTE DIR, BMP, EMP, DIST, YEAR, DC, TYPE, THK0, YEAR1, REH1, THK1, YEAR2, REH2, THK2, YEAR3, REH3, THK3, YEAR4, REH4, THK4, E0, N0, E1, N1, E2, N2, E3, N3, E4, N4, CODE, CRS98, CRS99, CRS90, CRS92, CRS94, CRS96, CRS98)

RTE	DIR	BMP	EMP	DIST	YEAR	DC	TYPE	THKO	YEAR1	REH1	THK1	YEAR2	REH2	THK2	YEAR3	REH3	THK3	YEAR4	REH4	THK4	E0	N0	E1	N1	E2	N2	E3	N3	E4	N4	CRS88	CRS90	CRS92	CRS94	CRS96	CRS98			
70	W	141.94	146.32	5	1971	Y	CRCP	8	1989	3	3	1999	3	3.25	0	0	0	0	0	0	16.71	18	17.8	10	4.416	2	0	0	0	0	9	8.5	8.4	7.3	6.9	7			
70	W	146.92	150.32	5	1969	Y	CRCP	8	1980	3	3	1994	3	3.25	0	0	0	0	0	0	7.46	11	18.79	14	14.33	7	0	0	0	0	6.8	5.6	5.2	7.3	6.6	7.5			
70	W	150.32	155.80	5	1969	Y	CRCP	8	1980	3	3	1994	3	3.25	0	0	0	0	0	0	2.08	10	18.79	14	14.33	7	0	0	0	0	6.8	5.6	5.2	7.3	6.6	7.5			
70	E	4.04	11.16	6	1989	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	2.54	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
72	E	4.04	11.16	6	1990	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	2.54	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	19.97	25.35	6	1991	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	25.35	30.73	6	1991	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	30.73	35.24	6	1991	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	35.24	41.75	6	1990	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.18	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	41.75	42.39	6	1912	N	BRID	0.1	0	0	0	0	0	0	0	0	0	0	0	0	2.65	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	42.39	45.82	6	1990	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.65	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	45.82	51.53	6	1990	N	CRCP	15	0	0	0	0	0	0	0	0	0	0	0	0	2.65	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	51.53	53.53	6	1979	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	4.15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	53.53	59.87	6	1979	Y	CRCP	8	1996	3	3.25	0	0	0	0	0	0	0	0	0	5.54	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	59.87	63.73	6	1979	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	5.54	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	63.73	68.07	6	1977	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	5.72	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	68.07	74.78	6	1977	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	5.72	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	74.78	81.39	6	1976	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	6.17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	81.39	91.66	6	1976	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	6.17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	91.66	94.99	6	1972	Y	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	7.39	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
72	E	94.99	96.86	6	1967	N	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	7.02	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	96.86	97.48	6	1961	N	CRCP	8	1993	3	3.25	0	0	0	0	0	0	0	0	0	9.36	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	103.00	108.60	6	1991	N	CRCP	10	0	0	0	0	0	0	0	0	0	0	0	0	9.36	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	108.60	111.90	6	1976	Y	CRCP	8	1998	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	111.90	112.39	6	1976	Y	CRCP	8	1998	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	112.39	114.37	6	1976	Y	CRCP	8	1998	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	114.37	115.66	6	1976	Y	CRCP	8	1998	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	115.66	117.28	6	1976	Y	CRCP	8	1997	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	117.28	118.77	6	1976	Y	CRCP	8	1997	5	4.5	0	0	0	0	0	0	0	0	0	10.31	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	118.77	124.24	6	1976	Y	CRCP	8	2000	3	3.25	0	0	0	0	0	0	0	0	0	10.42	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	124.24	132.16	5	1976	N	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	10.42	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	132.16	134.46	5	1977	N	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	9.98	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	134.46	140.63	5	1977	N	CRCP	8	0	0	0	0	0	0	0	0	0	0	0	0	9.98	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	140.63	143.16	5	1975	Y	CRCP	8	2000	3	3.25	0	0	0	0	0	0	0	0	0	10.38	25	0.622	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	143.16	144.96	5	1975	Y	CRCP	8	2000	3	3.25	0	0	0	0	0	0	0	0	0	10.38	25	0.622	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	144.96	151.49	5	1977	Y	CRCP	8	2000	3	3.25	0	0	0	0	0	0	0	0	0	10.38	25	0.622	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	151.49	156.51	5	1977	Y	CRCP	8	1992	3	3.25	0	0	0	0	0	0	0	0	0	9.97	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	156.51	161.15	5	1976	Y	CRCP	8	1997	5	4.5	0	0	0	0	0	0	0	0	0	9.97	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	161.15	165.96	5	1976	Y	CRCP	8	1997	5	4.5	0	0	0	0	0	0	0	0	0	9.97	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	E	165.96	166.47	5	1977	N	CRCP	10	1997	3	3.25	0	0	0	0	0	0	0	0	0	9																		

Table with columns: RTE DIR, BMP, EMP, DIST, YEAR, DC, TYPE, THK0, YEAR1, REH1, THK1, YEAR2, REH2, THK2, YEAR3, REH3, THK3, YEAR4, REH4, THK4, E0, N0, E1, N1, E2, N2, E3, N3, E4, N4, CODE, CRS88, CRS90, CRS92, CRS94, CRS96, CRS98.

Table with 26 columns: RTE DIR, BMP, EMP, DIST, YEAR, DC, TYPE, THK0, YEAR1, REH1, THK1, YEAR2, REH2, THK2, YEAR3, REH3, THK3, YEAR4, REH4, THK4, E0, N0, E1, N1, E2, N2, E3, N3, E4, N4, CODE, CRS88, CRS90, CRS92, CRS94, CRS96, CRS98. Contains routing data for various projects.

RTE	DIR	BMP	EMP	DIST	YEAR	DC	TYPE	THK0	YEAR1	REH1	THK1	YEAR2	REH2	THK2	YEAR3	REH3	THK3	YEAR4	REH4	THK4	E0	N0	E1	N1	E2	N2	E3	N3	E4	N4	CODE	CRS88	CRS90	CRS92	CRS94	CRS96	CRS98			
290	W	26.21	26.69	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	26.69	27.01	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	27.01	27.69	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	27.69	28.20	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	28.20	28.70	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	28.70	29.20	1	1956	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	11.17	12	25.77	18	28.99	12	8.014	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	29.20	29.78	1	1955	N	JRCP	10	1968	3	3	1986	5	5.25	0	0	0	0	0	0	10.70	12	24.46	18	26.47	12	6.49	3	0	0	7.4	6.8	8.3	5.7	4.3	9				
290	W	29.78	30.17	1	1955	N	JRCP	7	1968	3	3	1988	5	5.25	0	0	0	0	0	0	11.50	13	50.93	30	6.49	3	0	0	0	0	2	7.4	6.8	8.3	5.7	4.3	9			
355	N	32.20	33.50	1	1975	N	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	9.27	17	9.293	9	0	0	0	0	0	0	0	0	8.5	0	8.5	0	5.8	5.8		
355	N	33.50	34.00	1	1972	N	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	9.53	20	9.292	9	0	0	0	0	0	0	0	0	8.5	0	8.5	0	5.6	5.8		
355	S	33.50	34.00	1	1972	N	CRCP	9	1992	3	3.25	0	0	0	0	0	0	0	0	0	9.27	17	9.293	9	0	0	0	0	0	0	0	0	8.5	0	8.5	0	5.6	5.8		
394	N	0.00	3.95	1	1955	N	JRCP	10	1990	3	3.25	0	0	0	0	0	0	0	0	0	9.53	20	9.292	9	0	0	0	0	0	0	0	0	0	0	0	0	5.6	5.8		
394	S	0.00	3.95	1	1955	N	JRCP	10	1990	3	3.25	0	0	0	0	0	0	0	0	0	9.53	20	9.292	9	0	0	0	0	0	0	0	0	0	0	0	0	5.6	5.8		
394	S	0.00	3.95	1	1955	N	JRCP	10	1990	3	3.25	0	0	0	0	0	0	0	0	0	9.53	20	9.292	9	0	0	0	0	0	0	0	0	0	0	0	0	5.6	5.8		
474	E	0.00	0.59	4	1979	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	18.24	22	0	0	0	0	0	0	0	0	0	0	0	0	0	5.1	9	8.7	6.2	
474	E	0.00	0.59	4	1979	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	18.24	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.1	9	8.7	6.2
474	E	6.15	8.19	4	1981	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	17.52	20	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	E	6.15	8.19	4	1979	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	0	17.52	20	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	E	8.19	8.83	4	1912	Y	BRID	0.1	0	0	0	0	0	0	0	0	0	0	0	19.08	22	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2	
474	E	8.19	8.83	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	19.69	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	E	9.14	11.23	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	13.29	18	5.50	4	0	0	0	0	0	0	0	0	0	0	0	0	6	4.4	4.4	4.4	8.6
474	E	11.23	16.19	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	13.29	18	5.50	4	0	0	0	0	0	0	0	0	0	0	0	0	6	4.4	4.4	4.4	8.6
474	W	0.00	0.59	4	1979	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	13.29	18	5.50	4	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	W	0.59	6.15	4	1981	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	18.24	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	W	6.15	8.19	4	1979	N	CRCP	9	0	0	0	0	0	0	0	0	0	0	0	17.52	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	W	8.19	8.83	4	1912	Y	BRID	0.1	0	0	0	0	0	0	0	0	0	0	0	19.08	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	W	8.19	8.83	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	19.69	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7.8	7.4	6.7	6.2
474	W	9.14	11.23	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	13.29	18	5.50	4	0	0	0	0	0	0	0	0	0	0	0	0	6	4.4	4.4	4.4	8.6
474	W	11.23	16.19	4	1979	Y	CRCP	9	1997	5	5	0	0	0	0	0	0	0	0	13.29	18	5.50	4	0	0	0	0	0	0	0	0	0	0	0	0	6	4.4	4.4	4.4	8.6