CONDITION MONITORING OF CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

HP&R #5264
Final Report

by

Lewis G. Scholl
Technical Studies Coordinator

and

Eric W. Brooks
Research Specialist

Oregon Department of Transportation
Highway Division
Research Unit

Salem, Oregon 97310

for

Federal Highway Administration
Washington, D.C. 20590

March 1991

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle Condition Monitoring of Continuously Reinforced Concrete Pavement	5. Report Date March 1991
	6. Performing Organization Code
7. Author(s) Scholl, L.G. and Brooks, E.W.	8. Performing Organization Report No.
9. Performing Organization Name and Address Oregon Department of Transportation Oregon State Highway Division Materials & Research Section Salem, OR 97310	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. HPR5264
12. Sponsoring Agency Name and Address Oregon Department of Transportation Oregon State Highway Division Materials & Research Section Salem, OR 97310	13. Type of Report and Period Covered Final Jan. 1984 - June 1988
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This four-year study includes annual monitoring data from twenty-seven pavement sites in Oregon that were constructed using Continuously Reinforced Concrete Pavements (CRCP). Most of these pavements were between fifteen and twenty-five years old when the last distress survey was performed in 1988. Some of them have endured nearly fifteen million ESAL's and continue to perform well.

A comparison is made of distress observed in the field to distress predicted by equations developed for Texas and Illinois pavements. Oregon's CRCP show significantly less distress than those equations predict. Thus Oregon's CRCP have a longer service life (time to full depth overlay), than the twenty years anticipated. To develop failure prediction equations for Oregon, additional research is needed.

17. Key Words	18. Distribution Statement
PAVEMENTCONCRETE, continuously reinforced concrete pavement, condition monitoring, life cycle	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		28	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

INTRODUCTION 1

Background 1
Objective 1
Approach 1

DATA COLLECTION 2

Site Parameters 2
Condition Survey 3

DATA ANALYSIS 4

Visual Inspection 4
Deflection Measurements 5

STRUCTURAL RATINGS AND FAILURE PREDICTION 6

Texas Study 7
Illinois Study 9

MAINTENANCE AND CRCP REPAIRS OF FAILURES 10

SUMMARY AND CONCLUSION 12

APPENDIX A 13

APPENDIX B 16

APPENDIX C 19

APPENDIX D 20

APPENDIX E 24

APPENDIX F 25

APPENDIX G 26

APPENDIX H 27

REFERENCES 28

DISCLAIMER

This document is disseminated under the sponsorship of the U. S. Department of Transportation and the Oregon Department of Transportation in the interest of information exchange. The United States Government and the Oregon Department of Transportation assume no liability for its contents or use thereof.

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official policy of the U. S. Department of Transportation or the Oregon Department of Transportation.

The U. S. Department of Transportation and the Oregon Department of Transportation do not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the subject of this document.

This report does not constitute a standard, specification or regulation.

INTRODUCTION

Background

Oregon began using Continuously Reinforced Concrete Pavements (CRCP) in the early 1960's. By 1983, many of these pavements were reaching their anticipated service life of twenty years. The study was started in 1984 as a four-year study to gather information about the types and rates of distress on existing CRCP. Twenty-seven sites from twelve different construction projects were selected for monitoring. The central premise of the study was that detailed monitoring of short pavement sections would identify specific distress types that warn of impending failure or need for rehabilitation. After data was gathered for four years, it was apparent that a much longer evaluation period was needed to observe any significant trends. Since the Pavement Design Unit is now performing some of the same data gathering work, it was determined that the study should be concluded and the data converted to a new format developed by the Pavement Design Unit.

Objective

The objectives of this project were to: 1) Analyze the rates and types of deterioration occurring in CRCP; 2) Determine the probable cause or causes of this deterioration; and 3) Apply these findings to make recommendations for design, construction and maintenance improvements.

This report summarizes the data gathered, outlines the methods used in data collection and converts the data to the format currently being used by the Pavement Design Unit. Related research by others is also discussed and their prediction methods evaluated for use in Oregon.

Approach

In 1984, a survey was made of all the CRCP in the state. Twenty-seven sites were selected for annual monitoring under this study. These sites are located throughout the state and included pavements of different ages, traffic loadings and structural sections. All sites, however, are on the Interstate System and most are now between fifteen and twenty years old (See Table 1). Visual inspections, photographs, deflections and maintenance records were to be collected annually. However, the frequency of inspections was later reduced to bi-annually because of the slow rate of distress. Data collected by visual inspections included rut depths, cracking, edge and other surface conditions. Photographs were taken transverse to the roadway at each of the fifty-foot section boundaries. Deflections were taken with the "Dynaflect" for the first three years.

DATA COLLECTION

Site Parameters

Site parameters included structural section, traffic loadings and construction year. Construction sections were taken from "As Constructed Plans" obtained from the Final Design Section. Traffic loadings were computed from twenty year traffic coefficients which were derived by the Traffic Section.

The study included three basic construction section types (See Table 1):

No. Sites	Section
13	8" CRCP /PMAB
10	8" CRCP /CTB
4	8" CRCP /ACB

These represent twelve different construction projects, so that a variety of traffic loadings and ages are represented. Some projects have more than one test section. This was done to better determine the variation within each project. This sample is believed to fairly represent the CRCP sites in Oregon.

Table 1

Proj #	No. of Sites	Age (1988) (Years)	ESALS (1988) in millions	Structural Section (inches of) CRCP	ACB	CTB	PMAB	LTS
1	3	25	10.8	8			6	
2	3	22	9.3	8			11	
3	4	14	6.4	8	4		12	
4	4	18	13.7	8		6		6
5	2	23	14.5	8			9	
6	2	19	6.5	8			7	
7	2	16	6.4	8		4	6	
8	2	13	4.4	8		4	6	
9	2	20	5.7	8			7	
10	1	22	8.8	8			12	
11	1	18	8.5	8		4	5	6
12	1	18	6.6	8		6	6	

PMAB = Plant Mix Aggregate Base
CTB = Cement Treated Base
ACB = Asphalt Concrete Base
LTS = Lime Treated Subgrade

Condition Survey

Task 4 of the work plan outlined the following items to be included in an annual survey:

1. Amount and type of cracking
2. Rutting depth
3. Deflection (Dynaflect)
4. Photographic record of the site
5. Observed maintenance work

This information was to be gathered from sample sections which were 250 feet long. Each site was divided into five equal subsections of fifty-foot lengths. Deflections were taken at the beginning of each section and an additional five readings were taken at fifty-foot intervals for a total of eleven tests. Photographs were taken transversely from the shoulder at the section begin marks.

Definitions of the types and the severity levels of distress were taken from the, "Highway Pavement Distress Identification Manual," (Reference #3). Twenty different types of distresses are listed in this manual (most of which have been observed on CRCP highways in the United States. Because most of these were not found on Oregon Highways constructed with CRCP, they were not included on the pavement condition survey form.

Surface condition data and photographs were collected on all the sites for the years 1984, 1985, 1986 and 1988. Appendix A summarizes the Pavement Condition data. Deflections were taken in 1984, 1985 and 1986 and are shown in Appendix B.

Maintenance work performed by State forces was observed and recorded on the condition survey form. Some contract work was also performed on the projects. Two sites (4 and 5) had some full depth repairs made in the test section. Most of the maintenance work was minor crack sealing on the remainder of the jobs.

The photographs taken at each subsection marker have been placed in the individual job files. These pictures have been an excellent backup for the field visual inspections. Popouts, the type of and severity of cracking and the condition of the lane-shoulder joint all have been verified from the photographs.

DATA ANALYSIS

Visual Inspection

It can be seen from Appendix A that five years of service did not significantly change observed distress levels. There were some minor variations in the crack counts. These are thought to be due to having different inspectors each year and differences in temperature between rating periods. Lighting conditions also have an effect on the observations of low level transverse cracks.

The transverse cracking observed on the test sections was of a low severity level. Only minor spalling and no faulting was found. This kind of cracking is normal for CRCP and is not a serious defect unless faulting occurs.

Other studies have correlated the spacing of transverse cracking with edge punchout. One project (Sites 4, 5 and 6) did have edge punchouts when the project was started. However, none of the 250-foot test sections had a high enough level of punchout to be reported. Thus no punchout development was observed. This project was patched under contract in 1986. Most of the problems were caused by drainage failure.

Popouts were also reported on several test sections. The results shown in Appendix A represent inconsistent estimating of this defect rather than an actual change in the pavement surface. Photographs also indicate no significant changes in the number of popouts. This was one distress type that had not been well defined and caused confusion among inspectors. COPES (Reference #2) has eliminated this defect from the distress listing.

Other types of cracking observed included longitudinal cracking, "Y" cracking and map cracking. Examination of Appendix A reveals that these did not occur frequently nor were they of a significant distress level. No trends could be observed with time for these items.

Rut depths listed in Appendix A were taken with a specially constructed rut gauge. This device consisted of a six-foot aluminum I-beam with a calibrated rod at its center. The ruts measured were an average of the maximum depth found in the wheel path. No trend was observed in the ruts.

The final deficiency listed in Appendix A concerned the CRCP-ACC shoulder joint, although this was a maintenance problem with the shoulder rather than the travel lane. Lane shoulder dropoff is a safety hazard for the motoring public. Lane shoulder separation can contribute to weakening of the subgrade support by allowing moisture to penetrate into the base. No real trend was observed with lane shoulder dropoff or lane shoulder separation. Most of the observed cracks have been sealed at this time.

Deflection Measurements

Deflection measurements were taken with the Dynaflect from 1984 through 1986 on the CRCP sites. A reading was taken at the beginning of each subsection and an additional five readings were taken at fifty-foot intervals for a total of eleven readings. These eleven readings were then averaged to give a single reading for the site. Reference marks on the A.C. shoulder were used to obtain a deflection measurement at a point within two inches of the previous years readings.

Pavement temperatures were taken at one-half inch below the surface. However, a temperature correction was not made because of the complex manner in which temperature effects CRCP. An attempt was made to take measurements at about the same time of day and temperature.

The results of deflection measurements are summarized in Table 2. It was expected that deflection would increase with time. Most of the sites proved to be stable, with a few exceptions. Table 2 is a condensed version of Appendix B; values shown in Table 2 are averages for all twenty-seven sites.

Table 2

Year of Test	Maximum Deflection in Mills	Spread Percent	E1 Modulus of Concrete	E2 Modulus of Soil
1984	11.3	74.1	3,293	22.1
1985	9.5	76.8	4,917	23.9
1986	9.6	77.1	5,242	23.0

The soil and concrete moduli were derived from a nomogram developed for use by Dynaflect deflections (Reference #8). Average values of all sites indicate that the soil and concrete moduli were stable in 1985 and 1986. Some of the first observations made in 1984 are now believed to have an equipment calibration problem. They should not be used in making a comparison to 1985 and 1986 values. The two years, 1985 and 1986, do show that deflections and moduli remained nearly the same. The Ohio DOT had similar results in that they found that deflections did not significantly change until just before pavement failure. Oregon deflection measurements have not been taken over a long enough period of time to reach failure.

STRUCTURAL RATINGS AND FAILURE PREDICTION

In 1989, the Pavement Design Unit of the Oregon Department of Transportation (ODOT), Highway Division conducted a visual condition survey of most of the interstate system. The condition survey method used in the 1989 survey is now being modified for use as part of an ongoing Pavement Management System. For this reason the data gathered in this study can be more valuable when converted to the newly adopted format. This method is based on the COPES method. The following discussion describes the differences between the two methods and the method used to develop the conversion.

The Pavement Design Unit method is based on a deduct system to calculate a structural rating as shown in Appendix D. The Research Unit method is based on a count of distress occurrences on a section. Another major difference between the two systems was the amount of each project evaluated. The Research Unit method evaluated one 250-foot section per site, while the Pavement Design Unit evaluated the entire project. The interval used by the Pavement Design Unit was a section 0.1 miles long and distressed values were determined for each 0.1 mile interval throughout the project. Distress values were then summed for this interval and recorded. There were also other differences in the surveys. The Research Unit method counted the exact number of distress occurrences while Pavement Design used ranges (See Appendix F). The Pavement Design Unit also rated patch condition and lane joints. Rut depths were measured by the Pavement Design Unit at each milepost and rut depth estimates were recorded at 0.1 mile intervals. The Research Unit took thirty measurements on a site and averaged these to obtain one value for the site. Even with these differences, both surveys indicate that the sites studied were in good condition.

In order to convert Research Unit data to the Pavement Design Unit´s structural rating, certain assumptions were made:

1. The 250-foot test site represented the entire job.

2. Longitudinal cracks were low severity and totaled more than sixty feet per site.

3. No high severity cracks were observed.

Using the above assumptions, the computer program used to summarize the Research Unit's annual data was modified to compute the Pavement Design Unit's structural rating. The results of this comparison are summarized in Table 3. It can be seen that there was a good agreement between the two systems. Three figures were used in the Pavement Design Unit rating: 1) Job Average, 2) One mile average, 3) 0.1 mile average. The mile and the 0.1 mile averages were the ones located closest to the research site. Even though the average values were in close agreement, the overall correlation was poor. Thus the Pavement Design Unit's method cannot be used interchangeable with the data obtained by the Research Unit.

Table 3

Unit	Research	Pavement Design		
Length	250-feet	0.1 Mile	Mile	Job
Struc. Rate (Avg.)	88.2	90.7	90.5	89.6
R SQ	1.00	0.49	0.75	0.13

Texas Study

The state of Texas also began using CRCP in the early 1960's and by 1972 had constructed over three thousand miles of this type of pavement. A study of distress types was started in 1974 and continued through 1984. Several reports and studies were made on this data base.

A study by Machado related large aggregate type to failures per mile, while a later study by Saraf developed a correlation to the growth rate of failures to rainfall. The third study relates rainfall, coefficient of thermal expansion, and annual 18 Kip ESAL to distress growth rate and severe spalling of cracks.

A summary of the regression equations developed in this study are shown below (Reference #6):

Failure Model (Punchouts and Patches)

$$RGF = 10^{-5.23} \times COLE^{3.61} \times RAIN^{1.78} \times KIPS^{0.704} \qquad (R^2 = 0.65)$$

Severe Spall Model

$$SYM = 10^{-4.4} \times COLE^{2.69} \times RAIN^{1.67} \qquad (R^2 = 0.57)$$

Where:

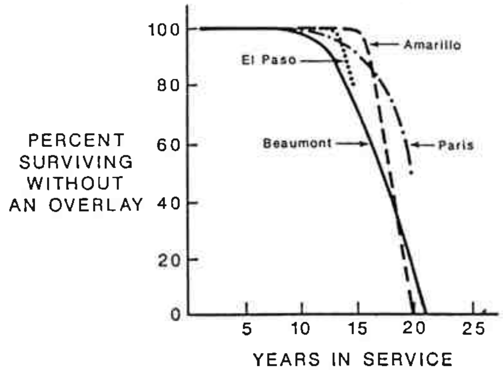
RGF = Rate Growth of Failures
COLE = Coefficient of Linear Expansion (inches/inches)
RAIN = Rainfall (inches/year)
KIPS = ESALS (millions)
SYM = Number of severely spalled cracks (per year)

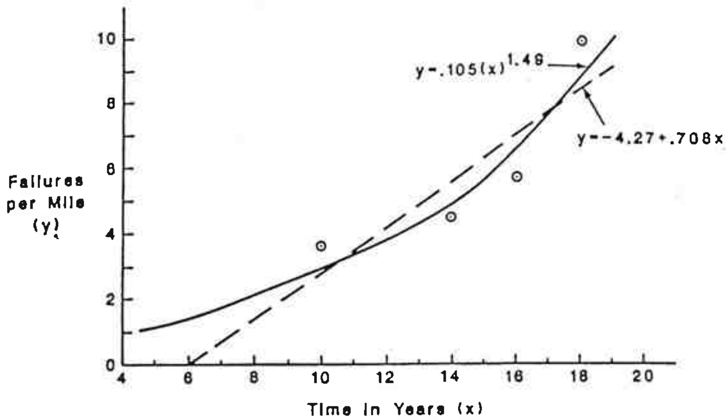
The authors of the above report believed that the R-Square value could be improved by adding other important variables. Some of these included subbase friction, gross overloads, and temperature variations in the early life. These factors are difficult to obtain. By restricting studies to limited, readily available data, the prediction equations would be limited to 60% accuracy.

Another interesting result of this study was the average time to major rehabilitation as a function of climatic condition; the summary is shown below:

Climate	Average Time to Rehabilitation (Years)
Wet/ Freeze Thaw	19.0
Dry/Freeze Thaw	18.6
Wet/No Freeze	17.7
Dry/No Freeze	N/A

The time until rehabilitation was nearly the same for all climate types except in the dry/no freeze district. No rehabilitation had been performed in this section because no failures had occurred and only a minor amount of crack spalling was reported.





The graphs at the left, were extracted from the third Texas study. Both show trends which support the average time to failure of about twenty years. They also indicate that failure, once it begins, grows rapidly.

It is possible that Oregon´s highways will have a longer average time to rehabilitation but that failure will increase rapidly. One interesting conclusion of the Texas study was that rainfall and design parameters had more effect on failures than traffic loadings. The Illinois study, discussed next, used only axle loads and design parameters to predict failures.

Illinois Study

A predictive model for CRCP deterioration was developed using a large Illinois data base. This data base was collected on 113 sites on the Illinois interstate system in 1974. Ten years later, twenty-four of the sites were reinspected and added to the data base. The equations were developed at the University of Illinois for the Illinois Department of Transportation. CRCP failures were defined as punchouts and patches of punchouts. Also included in the patching were repaired spalls and full depth repairs. The regression equation is listed below (See Reference #3).

$$FAIL = 0.0001673\ ESAL^{1.9839} \times THICK^{-4.2772} \times ASTEEL^{-5.0}$$

$$+\ 0.4127\ ESAL^{1.9553} \times (0.01584\ BAR + 1.9080\ CAM - 0.02005\ BAR)$$

$$(R^2 = 0.62)$$

Where:

FAIL = Number of punchouts and spalled cracks per mile
ESAL = Equivalent 18 Kip axle loads in millions
THICK = Thickness of CRCP in inches
ASTEEL = Area of the steel in inches square per inch of width
BAR = Rebar; 1 = Deformed bar; 0 = Wire mesh
CAM = Cement treated base (Oregon calls it CTB)

Notice that axle loads, concrete pavement design factors and subgrade treatment are included in the equation. Environmental factors are not included explicitly in this equation because only one climate type was included in the data base. However, because the equations were developed by multiple regression procedures, the climatic factors are implied. This could limit the usefulness of this equation to the wet/freeze climate for which it was developed. The correlation coefficient is in the same range as the value found in the Texas study and may indicate a trend for the accuracy of this type of equation.

Site data from the Oregon study were substituted in this equation to compare predicted to actual distress values. The complete results are shown in Appendix E. In general, the Oregon sites show less distress than predicted by the Illinois equation.

MAINTENANCE AND CRCP REPAIRS OF FAILURES

Distress surveys by both the Research Unit and the Pavement Design Unit found very few failures. There were fewer failures than those predicted by either the Texas model or Illinois model. This indicates that Oregon's CRCP is more durable.

However, sites in this state have had some distress. Repair contracts were let on four of the twelve projects included in the study. These contracts were completed in 1985 to 1987, so that the repairs were in-place when the Pavement Design Unit's surveys were conducted. Thus the exact distress type is not available except when it occurred within the Research Unit's evaluation site. (See Appendix E).

Excerpts from the Project Manager's narrative reports, that follow indicate that the distress was generally the results of original construction and design problems. They also indicate that once distress occurs, it tends to increase rapidly. Note the comment on the Lime Section about the increase distress from the time of the location survey to the beginning of the contract.

Azalea - Glendale Section (I-5, MilePost 81-87 SB)

"...our investigation of this project revealed that ten to fifteen percent of the outside lane has failed due to poor drainage, base pumping and poor concrete at night joints. Edge loadings also have been a significant factor in the failures..." (Increased edge loadings were the result of painting the fog strip one-foot to the right of the edge of concrete as shown in the job photographs). By Frank E. Terpin, Location Engineer.

S. Tigard Interchange - Willamette River Bridge (I-5, MilePost 84-87)

"...in almost all cases, pavement failures were at "night joints" or construction joints. Rebar was found misplaced or missing, lack of vibration and poor bulkhead procedures were the main culprits.

In only one or two cases was subbase suspect and these appeared to be temporary paving transactions or detour sections (Detour for stage construction). By Tom Shotwell, Project Manager.

Ladd Canyon - North Powder (I-84, MilePost 272 -278)

"In almost all the areas where the pavement had failed we found red cinders in the base. This layer of cinders was carrying water and found to be of varying depth. The existing rebar depth was checked and substantially was found to be correct. There were areas where the reinforcing steel was lying on the base or at the bottom of the concrete." By Joe Schlieski, Project Manager.

Lime Section

"Early in the contract, it became evident that the areas requiring repair were substantially greater than anticipated by the contract quantities. This was primarily due to cutting back the work identified in the location project and partially due to problem areas developing during the period between location and construction (Only about 1/2 mile of this project was included)." By Herb Shaw, Project Manager.

SUMMARY AND CONCLUSION

1. Most sites are now in good condition, and exhibited little or no change during the course of the study.

2. Most if not all of the failures in the pavements studied were caused by construction related problems rather than general fatigue failure or wear out.

3. There was not enough distress developed in only four years to develop prediction models.

4. Detailed distress data should continue to be collected as part of the pavement program. This data can be used in the future to develop reliable prediction equations for Oregon´s CRCP. The procedure currently used by the Pavement Design Unit should be suitable for this purpose.

5. Deflections do not appear to be a useful tool in predicting CRCP performance.

6. The maintenance management system should be developed and implemented to provide more detailed cost and treatment data on each section.

APPENDIX A

ANNUAL PAVEMENT CONDITION SURVEY

AND CONVERSION TO STRUCTURAL RATING

LONG TERM CRCP MONITORING

SITE	YR	TVL	TVM	TSPL	TSPM	LC	MP	YCR	PO	RUT	LSS	LSD	RATE
1	84	15	0	4	0	2	0	0	0	20	0	0	85
1	85	85	15	0	4	0	2	0	0	10	0	100	85
1	86	18	0	0	0	0	0	0	0	20	0	50	95
1	88	18	0	3	0	0	0	0	0	20	100	0	95
2	84	17	0	10	0	0	0	0	170	20	100	50	95
2	85	17	0	10	0	0	0	0	170	26	100	25	85
2	86	18	0	12	0	0	0	0	170	26	70	0	80
2	88	18	0	7	0	0	0	0	1000	30	80	0	80
3	84	9	0	3	0	0	0	0	100	20	0	0	95
3	85	9	0	3	0	0	0	0	100	10	40	0	95
3	86	18	0	0	0	0	0	0	9600	20	50	0	90
3	84	18	0	4	0	10	5	0	10600	20	70	20	80
4	84	18	0	8	0	0	3	0	2000	20	20	50	95
4	85	21	0	12	0	0	0	0	0	20	25	60	95
* 4	86	21	0	0	0	0	0	0	10100	10	25	100	95
4	88	21	0	10	0	0	0	0	10100	10	25	100	95
5	84	17	0	7	0	0	2	0	0	10	0	0	95
5	85	18	0	7	0	0	2	0	0	10	5	0	95
* 5	86	12	0	0	0	0	0	0	64	10	25	0	95
5	88	12	0	8	0	0	0	0	64	10	25	0	95
6	84	19	0	6	0	0	0	0	250	10	0	0	95
6	85	21	0	7	0	0	0	0	60	5	0	0	95
* 6	86	11	0	0	0	0	0	0	10060	10	25	0	95
6	88	11	0	7	0	0	0	0	10100	10	25	0	95
7	84	12	0	0	0	0	0	0	500	10	50	50	90
7	85	14	0	8	0	0	0	0	490	10	0	50	95
7	86	7	0	0	0	0	0	0	100	10	0	0	95
7	88	16	0	8	0	0	0	0	0	10	0	0	95
8	84	7	0	0	0	0	0	0	15	10	25	25	95
8	85	7	0	0	0	0	0	0	0	10	0	0	95
8	86	10	0	0	0	0	0	0	0	15	0	0	95
8	88	13	0	0	0	0	0	0	10	15	0	0	95
9	84	16	0	0	0	0	0	0	3	10	25	0	95
9	85	13	0	7	0	0	0	0	25	10	25	0	95
9	86	10	0	0	0	0	0	0	50	15	50	0	90
9	88	14	0	12	0	0	0	0	10	10	50	0	90
10	84	15	0	0	0	0	0	0	4	10	25	0	95
10	85	14	0	8	0	0	0	0	19	10	0	0	95
10	86	14	0	0	0	0	0	0	40	10	0	0	95
10	88	13	0	10	0	0	0	0	0	11	0	0	95

See Page 15 for Key to Column Headings

* Rehabilitation Work

APPENDIX A

ANNUAL PAVEMENT CONDITION SURVEY

AND CONVERSION TO STRUCTURAL RATING

LONG TERM CRCP MONITORING

SITE	YR	TVL	TVM	TSPL	TSPM	LC	MP	YCR	PO	RUT	LSS	LSD	RATE
11	84	18	0	12	0	0	0	0	68	20	20	70	95
11	85	22	0	0	0	0	0	0	25	20	125	0	95
11	86	17	0	0	0	0	0	2	83	10	25	0	95
11	88	19	0	12	0	0	0	0	0	10	0	0	95
12	84	14	0	13	0	0	0	0	0	20	25	60	95
12	85	15	0	10	0	0	0	0	0	20	13	25	95
12	86	14	0	0	0	0	0	0	0	10	100	50	95
12	88	16	0	12	1	0	0	0	0	20	150	30	90
13	84	13	0	8	0	0	0	0	37	10	0	0	95
13	85	14	0	8	0	0	0	0	37	10	20	0	95
13	86	11	0	0	0	0	0	0	50	10	0	50	95
13	88	12	0	11	1	0	0	0	17	17	150	0	90
14	84	14	0	13	0	0	0	0	37	10	20	0	95
14	85	14	0	11	0	0	0	0	37	21	25	0	85
14	86	13	0	0	0	0	0	0	50	0	150	25	95
14	88	15	0	11	2	0	0	0	17	20	170	0	90
15	84	7	0	0	0	0	0	0	25	30	50	0	80
15	85	7	0	0	0	0	0	0	25	30	50	0	80
15	86	13	0	0	0	0	0	0	50	30	50	0	80
15	88	15	0	11	2	0	0	0	100	30	75	0	75
16	84	12	0	0	0	0	0	0	25	20	80	25	90
16	85	12	0	1	0	0	0	0	25	20	80	25	90
16	86	15	0	0	0	0	0	0	50	20	50	0	90
16	88	10	0	10	0	0	0	0	20	10	100	0	90
17	84	14	0	3	0	1	0	0	20	10	50	0	80
17	85	14	0	4	0	1	0	0	250	20	500	0	80
17	86	17	0	8	0	1	0	0	25	20	50	0	80
17	88	16	0	9	0	1	0	0	20	20	50	25	80
18	84	17	0	6	0	1	0	0	20	10	100	0	85
18	85	17	0	6	0	1	0	0	20	10	50	0	85
18	86	15	0	5	0	1	0	0	200	17	50	0	85
18	88	17	0	9	0	1	0	0	20	17	50	25	85
19	84	18	0	9	0	1	0	5	20	10	0	100	80
19	85	18	0	9	0	1	0	5	20	10	0	0	80
19	86	18	0	18	0	1	0	5	15	10	0	125	85
19	88	20	0	18	0	1	0	6	21	10	0	0	85
20	84	12	0	5	0	1	0	4	25	10	50	25	85
20	85	14	0	8	0	1	0	5	25	10	50	25	85
20	86	11	0	0	0	1	0	0	19	15	0	60	85
20	88	14	0	12	0	1	0	0	150	15	0	75	85

See Page 15 for Key to Column Headings

* Rehabilitation Work

APPENDIX A

ANNUAL PAVEMENT CONDITION SURVEY

AND CONVERSION TO STRUCTURAL RATING

LONG TERM CRCP MONITORING

SITE	YR	TVL	TVM	TSPL	TSPM	LC	MP	YCR	PO	RUT	LSS	LSD	RATE
21	84	15	0	4	0	1	0	0	150	13	0	100	90
21	85	14	0	6	0	1	0	0	150	10	0	75	90
21	85	19	0	0	0	1	0	0	50	10	25	125	90
21	88	22	0	14	0	1	0	0	20	10	0	125	90
22	84	17	0	5	1	0	0	0	50	10	0	0	80
22	85	17	0	6	1	0	0	0	50	10	0	75	90
22	85	18	0	0	0	0	0	0	50	11	60	25	90
22	88	22	0	13	0	0	0	0	20	11	125	5	90
23	84	19	0	5	0	1	0	4	21	10	125	25	90
23	85	20	0	10	0	0	0	0	21	10	150	25	90
*23	86	21	0	0	0	0	0	3	21	10	125	0	95
23	88	22	0	18	0	0	0	2	21	10	125	25	95
24	84	21	0	10	0	0	0	0	1	10	150	20	95
24	85	22	0	10	0	0	0	0	2	10	150	20	95
*24	86	25	0	0	0	0	0	0	55	10	0	0	95
24	88	31	0	16	0	0	0	0	21	10	175	55	95
25	84	12	0	6	0	0	0	0	50	20	125	50	95
25	85	12	0	6	0	0	0	0	50	20	125	50	95
25	86	18	0	0	0	0	0	0	21	20	125	50	95
25	88	12	0	8	0	0	0	0	25	20	125	0	95
26	84	6	6	6	0	0	0	0	0	20	0	0	95
26	85	13	6	6	0	0	0	0	0	20	0	0	95
26	86	9	0	0	0	0	0	0	40	20	0	0	95
26	88	8	0	7	0	1	0	0	10	20	0	0	85
27	84	8	0	6	0	1	0	0	30	20	0	0	85
27	85	8	2	6	0	1	0	0	30	20	0	20	85
27	86	9	0	1	0	1	0	0	50	20	0	0	85
27	88	10	0	5	5	1	0	1	10	20	50	25	75

* Rehabilitation Work

Key to Column Headings:

SITE = Site number as shown in Appendix F
YR = Year of observation
TVL = Number of low severity transverse cracks
TVM = Number of medium transverse cracks
TSPL = Number of transverse cracks with a low spall
TSPM = Number of transverse cracks with a medium spall
LC = Longitudinal cracks
MP = Map cracking in percent of area
YCR = "Y" cracking in percent of area
PO = Estimated number of pop outs
RUT = Rut depth in 0.01 feet increments
LSS = Lane shoulder separation in inches x 100
LSD = Lane shoulder dropoff in inches x 100
RATE = Structural rating as calculated from Research data

APPENDIX B

DYNAFLECT DEFLECTION READINGS
CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

SITE	YEAR	W1	W2	W3	W4	W5	PVMT	SPR%	E1	E2
1	84	.50	.42	.34	.23	.15	48	65.60	1877	39.3
1	85	.45	.40	.25	.21	.14	46	64.44	1704	42.0
1	86	.45	.41	.29	.21	.14	52	66.67	2334	42.0
2	84	.60	.49	.41	.29	.21	48	66.67	1573	28.3
2	85	.58	.52	.38	.31	.22	50	69.31	2152	27.0
2	86	.59	.53	.39	.31	.22	63	69.15	2106	27.0
3	84	.39	.33	.27	.18	.12	48	66.15	2522	48.8
3	85	.33	.30	.17	.15	.10	43	63.64	2102	58.2
3	86	.36	.33	.24	.18	.12	65	68.33	3405	48.8
4	84	.60	.52	.44	.32	.23	65	70.33	2362	25.9
4	85	.54	.50	.41	.34	.24	67	75.19	4205	24.8
4	86	.54	.50	.40	.32	.23	74	73.70	3642	25.9
5	84	.61	.53	.43	.31	.22	65	68.85	2025	27.0
5	85	.57	.52	.41	.33	.22	71	71.93	3037	27.0
5	86	.61	.56	.48	.39	.30	65	76.72	4078	20.0
6	84	.50	.43	.34	.24	.16	67	66.80	2087	36.9
6	85	.49	.46	.37	.29	.19	70	73.47	4261	31.2
6	86	.46	.40	.32	.25	.18	60	70.00	2870	32.9
7	84	.33	.32	.29	.25	.22	53	85.45	14959	27.0
7	85	.31	.31	.26	.24	.20	42	85.16	15903	29.7
7	86	.32	.31	.27	.24	.21	69	84.37	13915	28.3
8	84	.46	.45	.38	.35	.30	70	84.35	9812	20.0
8	85	.41	.40	.35	.32	.27	53	85.37	12153	22.2
8	86	.47	.45	.38	.33	.28	52	81.28	7446	21.4
9	84	.48	.47	.42	.36	.32	62	85.42	10355	18.8
9	85	.43	.41	.35	.31	.26	45	81.86	8548	23.0
9	86	.42	.40	.34	.30	.26	67	81.90	8584	23.0
10	84	.48	.47	.40	.35	.30	64	83.33	8768	20.0
10	85	.43	.43	.37	.33	.28	54	85.58	12000	21.4
10	86	.42	.40	.35	.29	.24	62	80.95	8330	24.8
11	84	.49	.44	.40	.31	.27	56	77.96	5243	22.2
11	85	.42	.39	.32	.28	.22	55	77.62	6143	27.0
11	86	.46	.44	.38	.31	.25	64	80.00	7176	23.9
12	84	.47	.43	.39	.33	.27	70	80.43	6998	22.2
12	85	.43	.41	.33	.30	.24	55	79.53	7070	24.8
12	86	.43	.42	.37	.30	.25	61	82.33	9361	23.9
13	84	.57	.52	.49	.40	.35	56	81.75	6320	17.2
13	85	.48	.46	.42	.38	.33	60	86.25	10993	18.2
13	86	.59	.58	.52	.45	.39	59	85.76	8860	15.5

See Page 18 for Key to Column Headings

APPENDIX B

DYNAFLECT DEFLECTION READINGS
CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

SITE	YEAR	W1	W2	W3	W4	W5	PVMT	SPR%	E1	E2
14	84	.44	.40	.37	.31	.25	68	80.45	7558	23.9
14	85	.43	.41	.35	.31	.25	47	81.40	8427	23.9
14	86	.49	.48	.43	.37	.30	61	84.49	9964	20.0
15	84	.74	.66	.55	.47	.37	62	75.41	2836	16.3
15	85	.68	.65	.55	.46	.37	67	79.71	4740	16.3
15	86	.77	.72	.60	.51	.42	58	78.44	3611	14.4
16	84	.75	.66	.55	.46	.36	58	74.13	2486	16.7
16	85	.68	.65	.54	.44	.35	60	78.24	4210	17.2
16	86	.73	.68	.56	.47	.39	55	77.53	3482	15.5
17	84	.60	.52	.38	.28	.20	44	66.00	1501	29.7
17	85	.45	.42	.32	.23	.16	54	70.22	3311	36.9
17	86	.44	.41	.32	.24	.16	56	71.36	3846	36.9
18	84	.41	.38	.30	.23	.17	54	72.68	4296	34.8
18	85	.40	.39	.31	.25	.18	66	76.50	6530	32.9
18	86	.36	.33	.26	.19	.13	48	70.56	4241	45.1
19	84	.50	.41	.36	.30	.24	39	72.40	2962	24.8
19	85	.38	.36	.30	.24	.19	60	77.37	6877	31.2
19	86	.40	.38	.31	.26	.21	52	78.00	6727	28.3
20	84	.40	.34	.29	.24	.18	51	72.50	3972	32.9
20	85	.34	.33	.26	.23	.18	45	78.82	8611	32.9
20	86	.31	.31	.26	.21	.16	53	80.65	11942	36.9
21	84	.68	.58	.52	.44	.34	40	75.29	3034	17.7
21	85	.54	.50	.41	.35	.27	62	76.67	4492	22.2
21	86	.66	.61	.52	.42	.32	54	76.67	3807	18.8
22	84	.74	.61	.54	.42	.31	40	70.81	1881	19.4
22	85	.64	.59	.49	.40	.30	40	75.62	3568	20.0
22	86	.57	.52	.43	.33	.24	66	73.33	3335	24.8
23	84	.76	.64	.55	.39	.27	46	68.68	1622	22.2
23	85	.55	.52	.44	.34	.24	78	76.00	4644	24.8
23	86	.58	.52	.41	.31	.22	59	70.34	2469	27.0
24	84	1.05	.90	.81	.60	.44	43	72.38	1638	13.8
24	85	.74	.70	.59	.47	.34	76	76.76	3629	17.7
24	86	.75	.68	.54	.43	.32	54	72.53	2276	18.8
25	84	.67	.59	.51	.42	.34	61	75.52	3121	17.7
25	85	.67	.66	.54	.46	.36	72	80.30	5211	16.7
25	86	.71	.69	.59	.50	.41	66	81.69	5383	14.8
26	84	1.05	1.01	.90	.76	.64	61	83.05	4066	9.6
26	85	.72	.70	.61	.51	.44	44	82.78	5681	13.8
26	86	.69	.65	.55	.48	.39	62	80.00	4655	15.5

See Page 18 for Key to Column Headings

APPENDIX B

DYNAFLECT DEFLECTION READINGS
ON CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

SITE	YEAR	W1	W2	W3	W4	W5	PVMT	SPR%	E1	E2
27	84	.35	.32	.28	.21	.18	65	76.57	6586	32.9
27	85	.32	.31	.26	.22	.18	58	80.62	10614	32.9
27	86	.31	.30	.26	.21	.17	60	80.65	11259	34.8

Key to Column Headings:

SITE = Site number as shown in Appendix F
PVMT = Pavement temperature in degrees F
YR = Year of observation
SPR% = Spreadability; indicator of the pavement's load carrying capacity
Wn = Deflection reading of geophone number n, in mills

$$SPR\% = \frac{(W1 + W2 + W3 + W4 + W5)}{5 \times W1} \times 100\ \%$$

E1 = Modulus of the concrete in KSI (See Reference #8)
E2 = Modulus of the subgrade in KSI

APPENDIX C

Summary of Common Sites
(Research Unit & Pavement Design)

Long Term CRCP Monitoring							
Location				Structural Rating			
Site	Hwy	Tsbmp	DOT	Research	Pavement Design		
				250'	0.1 Mile	Mile	Job Ave.
2	1	23.900	NB	80	80	85	87
7	1	273.170	NB	95	95	95	95
9	1	277.800	NB	90	95	95	94
11	1	285.000	NB	95	94	95	95
13	1	286.900	NB	90	94	93	85
15	1	304.380	NB	75	84	82	95
18	6	204.000	WB	80	91	88	80
20	6	264.300	WB	85	91	88	80
22	6	283.900	WB	90	92	92	93
24	6	349.400	WB	95	95	94	95
Mean				88.2	90.7	90.5	89.1
Standard Deviation				7.2	4.9	4.5	6.1
Correlation (R2)					0.49	0.75	0.13

<u>Key To Column Headings</u>

TSBMP = Test Site Beginning Mile Point
DOT = Direction of Travel

APPENDIX D

Condition Survey Forms and Guidelines

INTERSTATE CONDITION SURVEY

The evaluation of Continuously Reinforced Concrete Pavements will be completed by rating the distress in the pavements according to the following descriptions and severity levels. In addition to rating the distress, the raters will note the width of the outside travel lane and the location of the fog stripe with respect to the edge of the concrete pavements.

RUTTING/WEAR

Rutting or wearing of the concrete pavement is a surface depression in the wheel path caused by permanent deformation or wearing away of the pavement surface.

The rut depth will be measured with a rut bar in the outside wheel track at each Mile Point marker. This measurement will be recorded on the condition survey form.

In addition a typical rut depth will be estimated for each section. This may be done visually, establishing the rut depth as Low, Medium or High according to the following criteria:

L - 1/4 - 1/2"
M - 1/2 - 3/4"
H - Over 3/4"

Should rut depths be less than 1/4", a 0 will be recorded in this column of the survey form.

LONGITUDINAL CRACKING

Longitudinal cracks are cracks that are parallel to the pavement centerline. The cracks will be rated as Low, Medium or High severity based on the following criteria:

L - Hairline crack with no spalling or a well sealed crack with no spalling.

M - Crack width less than 1/2" with moderate spalling.

H - Crack width greater than 1/2" or a crack with severe spalling.

The length of each longitudinal cracking will be estimated by pacing the length of the crack and totaling all crack lengths in the sections.

TRANSVERSE CRACKING

Transverse cracking of continually reinforced concrete pavement is normal and is not considered a form of distress. However, if the cracks open up they could lead to major distress.

Transverse cracks will be rated on the average crack condition according to the severity levels established for longitudinal cracks.

The amount of transverse cracking will be measured by recording the average spacing between cracks.

PUNCHOUTS

A punchout is when two transverse cracks are intersected by a longitudinal crack near the edge of pavement. The cracks involved form a block of concrete that is separated from the CRCP. As the cracks deteriorate the steel ruptures and the block of concrete punches downward into the base and subbase.

Punchouts will be rated as Low, Medium or High based on the following criteria:

- L - A longitudinal crack develops between two closely spaced transverse cracks. All cracks are tight with little or no spalling.
- M - The cracks have begun to widen with some spalling. The concrete is punched down less than 1/2 inch.
- H - Concrete within punchout is breaking up. Concrete is punched down more than 1/2 inch.

The amount of punchouts will be measured by counting the number that occur in each section.

It should be noted that if a punchout has been patched with asphalt, it should be rated as a high severity punchout and not a patch, as the patch is only a temporary repair.

JOINT CONDITION

The condition of joints will be rated based on both the condition of the joint and the seal condition. The condition of the joint will be based on the following criteria:

- L - Joint is in good condition and seal is in good condition.

M - Joint is slightly spalled and seal is in good condition or joint is good and seal is in poor condition.

H - Joint is spalled badly or joint is slightly spalled and seal is in poor condition.

The condition of both the lane and shoulder joints will be rated separately based on the average condition of the joints in each section.

PATCH CONDITION

A patch is an area where the original pavement has been removed and replaced with a permanent type of material.

The patch condition will be rated as Low, Medium or High based on the following criteria:

L - Patch has little or no deterioration.

M - Patch is somewhat deteriorated, may have some low severity cracking or spalling.

H - Patch is badly deteriorated with medium to high severity distress.

The amount of patching will be measured by estimating the percent of the outside lane that is patched.

The amount of patching in each severity level should be estimated for each.

APPENDIX D (CONTINUED)

Summary of Deduct Points **

Distress	Severity Level	Measurement Per Section	Deduct Points			
Rutting/ Wear	L	Mode value (circle one)	10			
	M		20			
	H		30			
Longitudinal Cracking		Linear feet	1-9	10-29	30-59	60+
	L	(circle one for each level)	2	5	7	10
	M		5	7	10	15
	H		7	10	15	20
Transverse Cracking	L	Mode Value (circle one)	0			
	M		10			
	H		20			
Punchouts			No.	EA.	points	
	L	number in each level	___ x	10	= _____	
	M		___ x	20	= _____	
	H		___ x	30	= _____	
Patch Condition		Lane Percent	1-24	25-49	50-74	75-100
	L	(circle one for each level)	5	7	10	15
	M		7	10	15	20
	H		10	15	20	30
Joint Condition	L	Mode Value (circle one)	0			
	M		5			
	H		10			

Point values from the above chart were used in the following equation to compute structural ratings.

RATE = 100 - (SUM OF DEDUCT POINTS)

** This system is being revised in 1991

APPENDIX E

Failure Predictions

(Illinois Equation Applied to Oregon Sites)

SITE	SA	BAM	CAM	BAR	PTRUCK	ADT	AGE	TOTSAL	AR	FAIL
1	.0460	0	0	1	15.4	15482	25.00	10.8		11
2	.0460	0	0	1	15.4	15482	25.00	10.8		11
3	.0460	0	0	1	15.4	15482	25.00	10.8		11
4	.0460	0	0	1	25.7	9500	21.00	9.3	11.4	8
5	.0460	0	0	1	25.7	9500	21.00	9.3	11.4	8
6	.0460	0	0	1	25.7	9500	21.00	9.3	11.4	8
7	.0460	1	0	1	15.3	29800	13.00	6.4		4
8	.0460	1	0	1	15.3	29800	13.00	6.4		4
9	.0460	1	0	1	15.3	29800	13.00	6.4		4
10	.0460	1	0	1	15.3	29800	13.00	6.4		4
11	.0460	0	1	1	14.0	53200	17.00	13.7	2.0	149
12	.0460	0	1	1	14.0	53200	17.00	13.7	2.0	149
13	.0460	0	1	1	14.0	53200	17.00	13.7	2.0	149
14	.0460	0	1	1	14.0	53200	17.00	13.7	2.0	149
15	.0460	0	0	1	9.7	69439	23.00	14.5		20
16	.0460	0	0	1	9.7	69439	23.00	14.5		20
17	.0460	0	0	1	27.8	6774	19.00	6.5		4
18	.0460	0	0	1	27.8	6774	19.00	6.5		4
19	.0460	0	1	1	38.0	4400	16.00	5.4		24
20	.0460	0	1	1	38.0	4400	16.00	5.4		24
21	.0460	0	1	1	38.0	4400	13.00	4.4	3.5	16
22	.0460	0	1	1	38.0	4400	13.00	4.4	3.5	16
23	.0460	0	0	1	37.3	3760	20.00	5.7	0.3	3
24	.0460	0	0	1	37.5	3760	20.00	5.7	0.3	3
25	.0460	0	0	1	5.6	53307	21.00	6.8		4
26	.0460	0	1	1	10.4	29985	17.00	8.5		58
27	.0460	0	1	1	7.8	46333	17.00	6.6		35

Key to Column Headings

SA = Area of reinforcement, in2/inch width of PCC slab
BAM = Base, aggregate material, 1 = yes, 0 = no
CAM = Cement, aggregate material, 1 = yes, 0 = no
BAR = Reinforcing steel type, deformed bar = 1, wire mesh = 0
PTRUCK = Percent of trucks in total ADT
ADT = Annual average daily traffic
AGE = Age of project in years (1988 - construction date)
TOTSAL = Total 18 KIP equivalent axle loads in the right lane
FAIL = Number of severe punchouts, deteriorated transverse cracks, and patches or full depth repairs per mile
AR = Percent of total travel lane surface repaired under contract

APPENDIX F

SITE LOCATION INDEX

OREGON DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION -MATERIALS AND RESEARCH SECTION

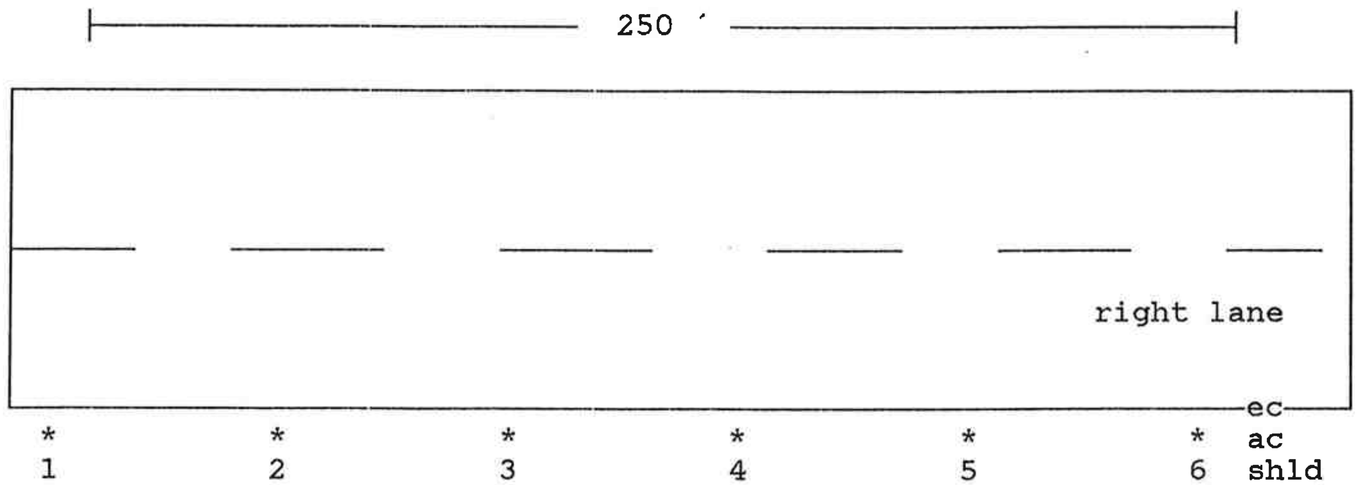
LONG TERM CRCP MONITORING

		LOCATION				
SITE NO.	HWY	BEGIN MILE	BEGIN SITE	END MILE	DOT	SECTION NAME
1	1	18.700	20.072	28.330	NB	NORTH ASHLAND-12TH STREET
2	1	18.700	23.900	28.330	NB	NORTH ASHLAND-12TH STREET
3	1	18.700	26.500	28.330	SB	NORTH ASHLAND-12TH STREET
4	1	81.420	85.230	87.350	SB	GLENDALE-AZALEA
5	1	81.420	86.940	87.350	SB	GLENDALE-AZALEA
6	1	81.420	87.240	87.350	SB	GLENDALE-AZALEA
7	1	272.220	273.170	281.320	NB	WOODBURN-HUBBARD
8	1	272.220	277.000	281.320	SB	WOODBURN-HUBBARD
9	1	272.220	277.800	281.320	NB	WOODBURN-HUBBARD
10	1	272.220	280.460	281.320	SB	WOODBURN-HUBBARD
11	1	284.300	285.000	287.610	NB	WLISONVILLE-EAST PORTLAND FREEWAY
12	1	284.300	285.000	287.610	SB	WLISONVILLE-EAST PORTLAND FREEWAY
13	1	284.300	286.900	287.610	NB	WLISONVILLE-EAST PORTLAND FREEWAY
14	1	284.300	287.200	287.610	SB	WLISONVILLE-EAST PORTLAND FREEWAY
15	1	303.700	304.380	305.840	NB	MINNESOTA FREEWAY
16	1	303.700	304.350	305.840	SB	MINNESOTA FREEWAY
17	6	188.050	192.950	204.430	EB	STANFIELD JCT-PENDLETON
18	6	188.050	204.000	204.430	WB	STANFIELD JCT-PENDLETON
19	6	259.200	261.100	265.510	EB	LAGRANDE
20	6	259.200	264.300	265.510	WB	LAGRANDE
21	6	276.070	281.200	285.330	EB	LADD CANYON-N.POWDER
22	6	276.070	283.900	285.330	WB	LADD CANYON-N.POWDER
23	6	345.800	347.500	353.300	EB	LIME-MALHEUR COUNTY LINE
24	6	345.800	349.400	353.300	WB	LIME-MALHEUR COUNTY LINE
25	61	1.050	1.390	1.410	NB	SW MONTGOMERY-SW BROADWAY
26	64	3.980	4.900	8.760	NB	WEST LINN-TUALATIN RIVER
27	64	14.580	15.210	17.050	NB	CAUSEY AVE-FOSTER ROAD

APPENDIX G

Site Layout

The beginning of each site was marked with a right-of-way paddle and post. Every subsection was marked by a p.k. nail 3´ from the edge of concrete in the asphalt shoulder. Dynaflect readings were taken 2.5´ to the left of the edge of concrete. All readings were taken within 2" of the mark obtained from the reference point.



APPENDIX H

Surface Condition Form

CRCP PAVEMENT SURVEY **Hwy ___,EB NB SB NB** (circle one) **MP______** **Date_________**

NUMBER OF OCCURRENCES PER 50 FOOT SECTION

	0-50'	50-100'	100-150'	150-200'	200-250'
Transverse Cracks L (tight, no fault)					
M (<1/4", no fault)					
H (>1/4", fault)					
Transverse Spalling L (1/4" - 1/2")					
M (<1/2" - 7/8")					
H (>7/8")					
Longitudinal Cracks L (tight, no fault)					
M (<1/4" fault)					
H (>1/4" fault)					
Longitudinal Spalling: L (1/4" - 1/2")					
M (1/2" - 7/8")					
H (>7/8")					
Map Cracking Present %					
"Y" Cracking Present %					
Popouts (#/50'section)					
Avg Rut Depth-1/100 ft. (6 per 50' section)					
Const Joint Separation					
Ln/Shoulder Separation					
Lane/Shoulder Drop Off					

Remarks: (ex: Any patching/construction done since last year's inspection?)

REFERENCES

1. Roger E. Smith et al, Highway Pavement Distress Identification Manual, Interim Report, (Washington, D.C.: Federal Highway Administration, March 1979), pp. 150 - 195.

2. M.I. Darter et al, Portland Cement Concrete Pavement Evaluation System, National Cooperative Highway Research Program Report 277, (Washington, D.C.: National Research Council, September 1985), pp. 108 - 129.

3. William F. Edwards et al, Implementation of a Dynamic Deflection System for rigid and Flexible Pavements in Ohio, (Columbus, Ohio: Ohio Department of Transportation, August 1989.

4. K.W. Heinrichs et al, Rigid Pavement Analysis and Design, FHWA Report No. FHWA-RD-88-068, Washington, D.C.: Federal Highway Administration, June 1989).

5. K.T. Hall et al, Rehabilitation of Concrete Pavements, FHWA Report No. FHWA-RD-88-073, (Washington, D.C.: Federal Highway Administration, June 1989).

6. T. Scullion, P.E., The Performance of Continuously Reinforced Concrete Pavements In Texas, (Riverdale, Maryland: National Asphalt Pavement Association).

7. Scofield, John T., A study of Oregon's Surface Design Procedures, (Salem, Oregon: Oregon Department of Transportation, January, 1979).

8. Majidzadeh, Kamran, Manual of Operation and Use of Dynaflect for Pavement Evaluation, (Columbus, Ohio: Ohio Department of Transportation, October 1983).

9. Darter, M. I., S. A. LaCoursiere and S. A. Smiley, Structural Distress Mechanisms in Continuously Reinforced Concrete Pavement, Transportation Research Record No. 715, Transportation Research Board, 1979, pp. 1-6.