PDHonline Course C405 (3 PDH)

Concrete Pavement - Distress Identification

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DISTRESS IDENTIFICATION MANUAL

for the Long-Term Pavement Performance Program

U.S. Department of Transportation
Federal Highway Administration

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Foreword

In 1987, the Strategic Highway Research Program began the largest and most comprehensive pavement performance test in history—the Long-Term Pavement Performance (LTPP) program. During the program's 20-year life, highway agencies in the United States and 15 other countries will have collected data on pavement condition, climate, and traffic volumes and loads from more than 1,000 pavement test sections. That information will allow pavement engineers to design better, longer-lasting roads.

This manual was developed to provide a consistent, uniform basis for collecting distress data for the LTPP program.

This manual provides a common language for describing cracks, potholes, rutting, spalling, and other pavement distresses being monitored by the LTPP program.

The manual is divided into three sections, each focusing on a particular type of pavement: (1) asphalt concrete-surfaced, (2) jointed portland cement concrete, and (3) continuously reinforced portland cement concrete. Each distress is clearly labeled, described, and illustrated.

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Notice

Technical Report Documentation Page

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16. Abstract

Accurate, consistent, and repeatable distress evaluation surveys can be performed by using the *Distress Identification Manual for the Long-Term Pavement Performance Program.* Color photographs and drawings illustrate the distresses found in three basic pavement types; asphalt concrete-surfaced; jointed (plain and reinforced) portland cement concrete; and continuously reinforced concrete. Drawings of the distress types provide a reference to assess their severity. Methods for measuring the size of distresses and for assigning severity levels are given. The manual also describes how to conduct the distress survey, from obtaining traffic control to measuring the cracks in the pavement. Sample forms for recording and reporting the data are included. The manual also tells how to calibrate and operate fault measurement devices.

17. Key Words Distress, LTPP, pavement, cracking, rutting, faulting.	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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

(Revised March 2002)

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DISTRESSES FOR PAVEMENTS WITH CONTINUOUSLY REINFORCED CONCRETE SURFACES / 59

Preface

The Strategic Highway Research Program (SHRP) was created as a 5-year program. The goals of SHRP's Long-Term Pavement Performance (LTPP) program, however, required an additional 15 years of research. To meet these goals, LTPP was transferred from SHRP to the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (DOT) on July 1, 1992, in accordance with the mandate of the Intermodal Surface Transportation Efficiency Act of 1991.

The first SHRP *Distress Identification Manual for the Long-Term Pavement Performance Studies* (1987) was authored by Kurt D. Smith, Michael I. Darter, Kathleen T. Hall, and J. Brent Rauhut. Support for that work was provided by the FHWA under Contract No. DTFH61-85-C-0095 as part of a "transition plan" to support planned implementation of LTPP monitoring, pending SHRP funding authorization by Congress.

A second version, the *Distress Identification Manual for the Long-Term Pavement Performance Studies* (1990), was developed by Karen Benson, Humberto Castedo, and Dimitrios G. Goulias, with guidance and support from W. R. Hudson. Support for the revision work was provided by SHRP as a part of Contract SHRP-87-P001.

A third version was developed by John S. Miller, Richard Ben Rogers, and Gonzalo R. Rada, with guidance and support from William Yeadon Bellinger, of the FHWA. Guidance was also provided by the Distress Identification Manual Expert Task Group.

Valuable information, material, and technical support were provided by: the National Association of Australian State Road Authorities; Ontario Ministry of Transportation and Communications; American Public Works Association; the Asphalt Institute; the Kentucky Transportation Cabinet; the Michigan DOT; the Mississippi State Highway Department; the Missouri Highway and Transportation Department; the North Carolina DOT; the Pennsylvania DOT; the Texas DOT; and the Washington State DOT.

This fourth version is the result of 8 years of practical experience using the third version. It incorporates refinements, changes, and LTPP directives that have occurred over time.

GUIDANCE TO LTPP USERS

Please follow the guidelines in appendix A ("Manual for Distress Surveys") to ensure the data collected will be comparable to other LTPP data. Sample data collection sheets are included in the appendix. As you evaluate a section of roadway, keep the manual handy to determine the type and severity of distress, and find the definition and illustration that best matches the pavement section being surveyed.

Appendix B describes how to use the Georgia Digital Faultmeter. Chapter 3 of the LTPP Manual for Profile Measurements Using the Face Dipstick®, v. 4.0, September, 2002, is shown in appendix C.

For more assistance in the identification of pavement distress, contact the FHWA's LTPP program.

GUIDANCE TO OTHER USERS

As a pavement distress dictionary, the manual will improve communications within the pavement community by fostering more uniform and consistent definitions of pavement distress. Highway agencies, airports, parking facilities, and others with significant investment in pavements will benefit from adopting a standard distress language.

Colleges and universities will use the manual in highway engineering courses. It also serves as a valuable training tool for highway agencies. Now when a distress is labeled "high severity fatigue cracking," for example, it is clear exactly what is meant. Repairs can be planned and executed more efficiently, saving the highway agency crew time and money.

Although not specifically designed as a pavement management tool, the *Distress Identification Manual* can play an important role in a State's pavement management program by ridding reports of inconsistencies and variations caused by a lack of standardized terminology. Most pavement management programs do not need to collect data at the level of detail and precision required for the LTPP program, nor are the severity levels used in the manual necessarily appropriate for all pavement management situations. Thus, you may choose to modify the procedures (but not the definitions) contained in the manual to meet your specific needs, taking into account the desired level of detail, accuracy and timeliness of information, available resources, and predominant types of distress within the study area.

This section covers jointed (plain and reinforced) portland cement concrete-surfaced pavements (JCP), including jointed concrete overlays on PCC pavements. Each of the distresses has been grouped into one of the following categories:

- **A.** Cracking
- **B.** Joint Deficiencies
- **C.** Surface Defects
- **D.** Miscellaneous Distresses

Table 2 summarizes the various types of distress and unit of measurement. Some distresses also have defined severity levels.

TABLE 2. Jointed Concrete-Surfaced Pavement Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
A. Cracking / page **35**		
1. Corner Breaks	Number	Yes
2. Durability Cracking ("D" Cracking)	Number of Slabs, Square Meters	Yes
3. Longitudinal Cracking	Meters	Yes
4. Transverse Cracking	Number, Meters	Yes
B. Joint Deficiencies / page **43**		
5a. Transverse Joint Seal Damage	Number	Yes
5b. Longitudinal Joint Seal Damage	Number, Meters	No
6. Spalling of Longitudinal Joints	Meters	Yes
7. Spalling of Transverse Joints	Number, Meters	Yes
C. Surface Defects / page **47**		
8a. Map Cracking	Number, Square Meters	No
8b. Scaling	Number, Square Meters	No
9. Polished Aggregate	Square Meters	No
10. Popouts	Not Measured	N/A
D. Miscellaneous Distress / page **51**		
11. Blowups	Number	No
12. Faulting of Transverse Joints and Cracks	Millimeters	No
13. Lane-to-Shoulder Dropoff	Millimeters	No
14. Lane-to-Shoulder Separation	Millimeters	No
15. Patch/Patch Deterioration	Number, Square Meters	Yes
16. Water Bleeding and Pumping	Number, Meters	No

This section includes the following types of distresses:

1. Corner Breaks
2. Durability Cracking ("D" Cracking)
3. Longitudinal Cracking
4. Transverse Cracking

Figure 47 illustrates the proper measurement of crack width and width of spalling for cracks and joints.

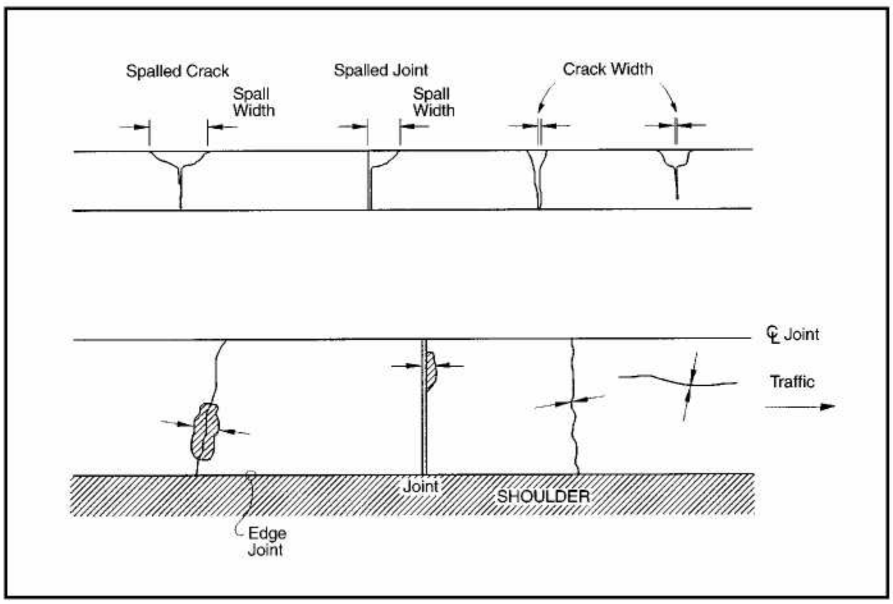

FIGURE 47
Measuring Widths of Spalls and Cracks in Jointed Concrete Pavement

CORNER BREAKS

1

Description

A portion of the slab separated by a crack, which intersects the adjacent transverse and longitudinal joints, describing approximately a 45-degree angle with the direction of traffic. The length of the sides is from 0.3 m to one-half the width of the slab on each side of the corner.

Severity Levels

LOW

Crack is not spalled for more than 10 percent of the length of the crack; there is no measurable faulting; and the corner piece is not broken into two or more pieces and has no loss of material and no patching.

MODERATE

Crack is spalled at low severity for more than 10 percent of its total length; or faulting of crack or joint is < 13 mm; and the corner piece is not broken into two or more pieces.

HIGH

Crack is spalled at moderate to high severity for more than 10 percent of its total length; or faulting of the crack or joint is ≥ 13 mm; or the corner piece is broken into two or more pieces or contains patch material.

How to Measure

Record number of corner breaks at each severity level. Corner breaks that have been repaired by completely removing all broken pieces and replacing them with patching material (rigid or flexible) should be rated as a patch. If the boundaries of the corner break are visible, then also rate as a high severity corner break. Note: This does not affect the way patches are rated. All patches meeting the size criteria are rated.

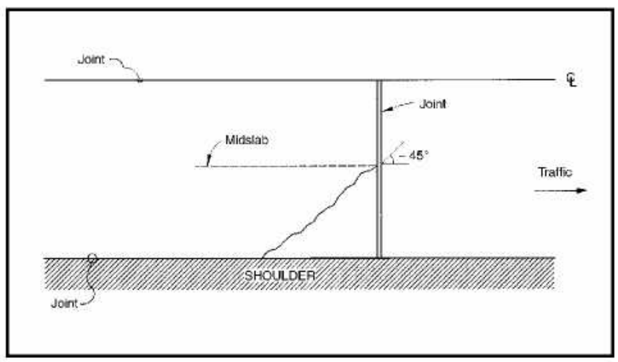

FIGURE 48
Distress Type JCP 1—Corner Breaks

FIGURE 49
Distress Type JCP 1—Low Severity Corner Break

FIGURE 50
Distress Type JCP 1—Moderate Severity Corner Break

JOINTED PORTLAND CEMENT CONCRETE SURFACES

DURABILITY CRACKING ("D" CRACKING)

Description

Closely spaced crescent-shaped hairline cracking pattern.

Occurs adjacent to joints, cracks, or free edges; initiating in slab corners. Dark coloring of the cracking pattern and surrounding area.

How to Measure

Record number of slabs with "D" cracking and square meters of area affected at each severity level. The slab and affected area severity rating is based on the highest severity level present for at least 10 percent of the area affected.

Severity Levels

LOW
"D" cracks are tight, with no loose or missing pieces, and no patching is in the affected area.

MODERATE
"D" cracks are well-defined, and some small pieces are loose or have been displaced.

HIGH
"D" cracking has a well-developed pattern, with a significant amount of loose or missing material. Displaced pieces, up to 0.1 m^2, may have been patched.

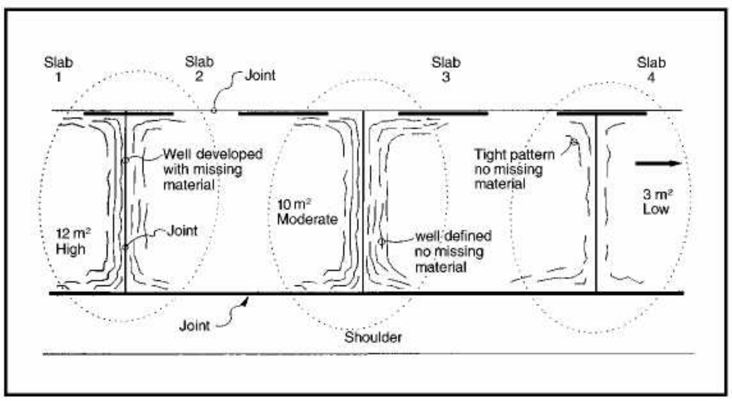

FIGURE 51
Distress Type JCP 2—Durability Cracking ("D" Cracking)

FIGURE 52
Distress Type JCP 2—Moderate Severity "D" Cracking with Well-Defined Pattern

FIGURE 53
Distress Type JCP 2—High Severity "D" Cracking with Loose and Missing Material

LONGITUDINAL CRACKING

Description

Cracks that are predominantly parallel to the pavement centerline.

Severity Levels

LOW

Crack widths < 3 mm, no spalling and no measurable faulting; or well-sealed and with a width that cannot be determined.

MODERATE

Crack widths ≥ 3 mm and < 13 mm; or with spalling < 75 mm; or faulting up to 13 mm.

HIGH

Crack widths ≥ 13 mm; or with spalling ≥ 75 mm; or faulting ≥ 13 mm.

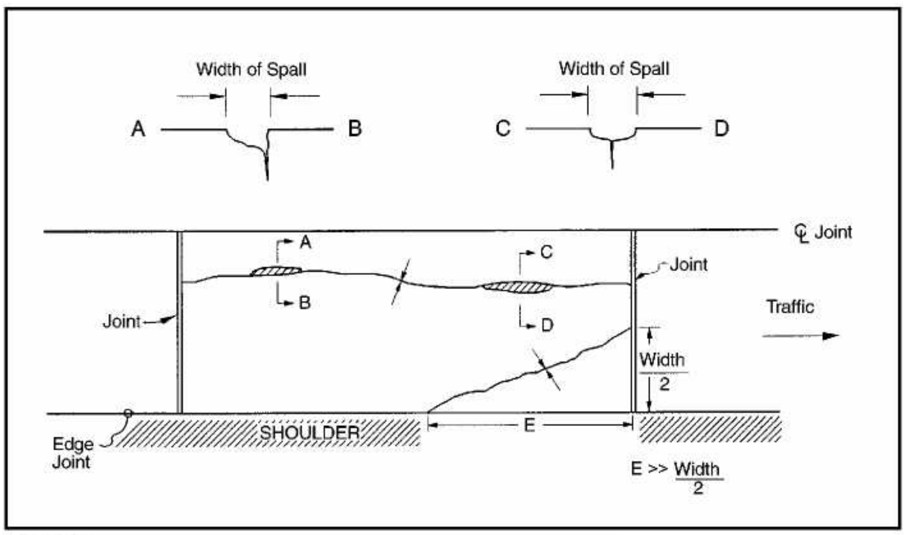

FIGURE 54
Distress Type JCP 3—Longitudinal Cracking

How to Measure

Record length in meters of longitudinal cracking at each severity level. Also record length in meters of longitudinal cracking with sealant in good condition at each severity level.

FIGURE 55
Distress Type JCP 3—Low Severity Longitudinal Cracking

FIGURE 56
Distress Type JCP 3—Moderate Severity Longitudinal Cracking

FIGURE 57
Distress Type JCP 3—High Severity Longitudinal Cracking

TRANSVERSE CRACKING

Description

Cracks that are predominantly perpendicular to the pavement centerline.

Severity Levels

LOW
Crack widths < 3 mm, no spalling and no measurable faulting; or well-sealed and the width cannot be determined.

MODERATE
Crack widths ≥ 3 mm and < 6 mm; or with spalling < 75 mm; or faulting up to 6 mm.

HIGH
Crack widths ≥ 6 mm; or with spalling ≥ 75 mm; or faulting ≥ 6 mm.

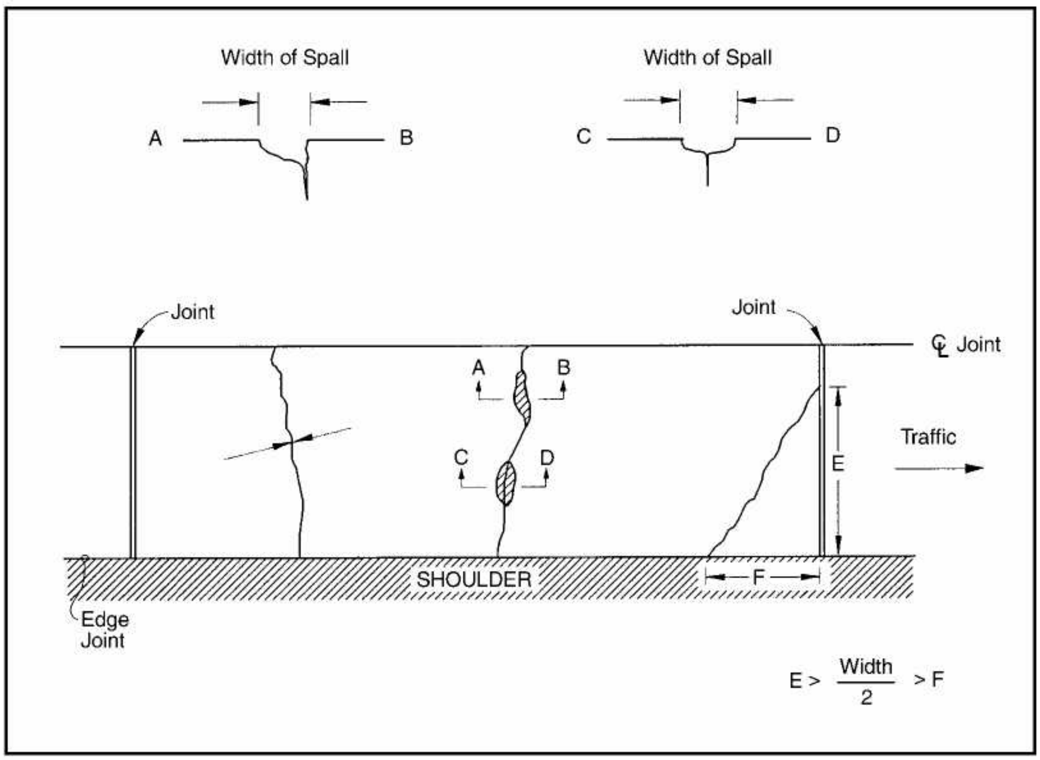

FIGURE 58
Distress Type JCP 4—Transverse Cracking

How to Measure

Record number and length of transverse cracks at each severity level. Rate the entire transverse crack at the highest severity level present for at least 10 percent of the total length of the crack. Length recorded, in meters, is the total length of the crack and is assigned to the highest severity level present for at least 10 percent of the total length of the crack.

Also record the length, in meters, of transverse cracking at each severity level with sealant in good condition. The length recorded, in meters, is the total length of the well-sealed crack and is assigned to the severity level of the crack. Record only when the sealant is in good condition for at least 90 percent of the length of the crack.

FIGURE 59
Distress Type JCP 4—Moderate Severity Transverse Cracking

FIGURE 60
Distress Type JCP 4—High Severity Transverse Cracking

B

Joint Deficiencies

This section includes the following types of distresses:

- **5a.** Transverse Joint Seal Damage
- **5b.** Longitudinal Joint Seal Damage
- **6.** Spalling of Longitudinal Joints
- **7.** Spalling of Transverse Joints

JOINT SEAL DAMAGE

Description

Joint seal damage is any condition which enables incompressible materials or water to infiltrate the joint from the surface. Typical types of joint seal damage are:

Extrusion, hardening, adhesive failure (bonding), cohesive failure (splitting), or complete loss of sealant.

Intrusion of foreign material in the joint.

Weed growth in the joint.

5a. *TRANSVERSE JOINT SEAL DAMAGE*

Severity Levels

LOW
Joint seal damage as described above exists over less than 10 percent of the joint.

MODERATE
Joint seal damage as described above exists over 10-50 percent of the joint.

HIGH
Joint seal damage as described above exists over more than 50 percent of the joint.

FIGURE 61
Distress Type JCP 5—Low Severity Joint Seal Damage

How to Measure

Indicate whether the transverse joints have been sealed (yes or no). If yes, record number of sealed transverse joints at each severity level. Any joint seal with no apparent damage is considered to be low severity.

5b. *LONGITUDINAL JOINT SEAL DAMAGE*

Severity Levels

None.

How to Measure

Record number of longitudinal joints that are sealed (0, 1, 2). Record total length of sealed longitudinal joints with joint seal damage as described above. Individual occurrences are recorded only when at least 1 m in length.

FIGURE 62
Distress Type JCP 5—Moderate Severity Joint Seal Damage

SPALLING OF LONGITUDINAL JOINTS

Description

Cracking, breaking, chipping, or fraying of slab edges within 0.3 m from the face of the longitudinal joint.

Severity Levels

LOW

Spalls < 75 mm wide, measured to the face of the joint, with loss of material, or spalls with no loss of material and no patching.

MODERATE

Spalls 75 mm to 150 mm wide, measured to the face of the joint, with loss of material.

HIGH

Spalls > 150 mm wide, measured to the face of the joint, with loss of material or is broken into two or more pieces or contains patch material.

How to Measure

Record length in meters of longitudinal joint affected at each severity level. Only record spalls that have a length of 0.1 m or more. Spalls that have been repaired by completely removing all broken pieces and replacing them with patching material (rigid or flexible) should be rated as a patch. If the boundaries of the spall are visible, then also rate as a high severity spall. Note: All patches meeting size criteria are rated as patches.

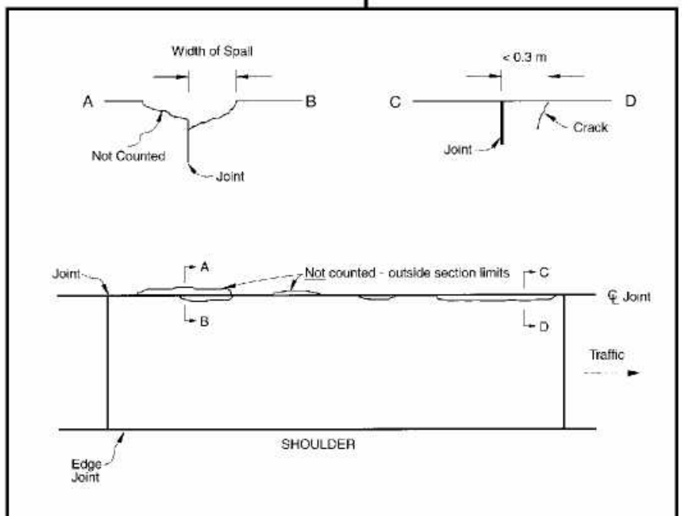

FIGURE 63
Distress Type JCP 6—Spalling of Longitudinal Joints

FIGURE 64
Distress Type JCP 6—Low Severity Spalling of Longitudinal Joint

FIGURE 65
Distress Type JCP 6—High Severity Spalling of Longitudinal Joint

7

SPALLING OF TRANSVERSE JOINTS

Description

Cracking, breaking, chipping, or fraying of slab edges within 0.3 m from the face of the transverse joint.

Severity Levels

LOW
Spalls < 75 mm wide, measured to the face of the joint, with loss of material, or spalls with no loss of material and no patching.

MODERATE
Spalls 75 mm to 150 mm wide, measured to the face of the joint, with loss of material.

HIGH
Spalls > 150 mm wide, measured to the face of the joint, with loss of material, or broken into two or more pieces, or contains patch material.

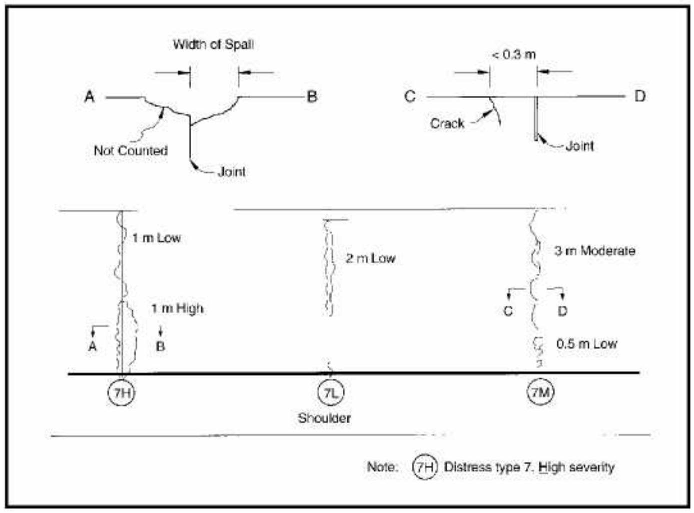

FIGURE 66
Distress Type JCP 7—Spalling of Transverse Joints

How to Measure

Record number of affected transverse joints at each severity level. A joint is affected only if the total length of spalling is 10 percent or more of the length of the joint. Rate the entire transverse joint at the highest severity level present for at least 10 percent of the total length of the spalling.

Record length in meters of the spalled portion of the joint at the assigned severity level for the joint. Spalls that have been repaired by completely removing all broken pieces and replacing them with patching material (rigid or flexible) should be rated as a patch. If the boundaries of the spall are visible, then also rate as a high severity spall. Note: All patches meeting size criteria are rated as patches.

FIGURE 67
Distress Type JCP 7—Moderate Severity Spalling of Transverse Joint, Far View

FIGURE 68
Distress Type JCP 7—Moderate Severity Spalling of Transverse Joint, Close-up View

C

Surface Defects

This section includes the following types of distresses:

- **8a.** Map Cracking
- **8b.** Scaling
- **9.** Polished Aggregate
- **10.** Popouts

MAP CRACKING AND SCALING

8a. ***MAP CRACKING***

Description

A series of cracks that extend only into the upper surface of the slab. Larger cracks frequently are oriented in the longitudinal direction of the pavement and are interconnected by finer transverse or random cracks.

Severity Levels

Not applicable.

How to Measure

Record the number of occurrences and the square meters of affected area.

FIGURE 69
Distress Type JCP 8a—Map Cracking

8b. ***SCALING***

Description

Scaling is the deterioration of the upper concrete slab surface, normally 3 mm to 13 mm, and may occur anywhere over the pavement.

Severity Levels

Not applicable.

How to Measure

Record the number of occurrences and the square meters of affected area.

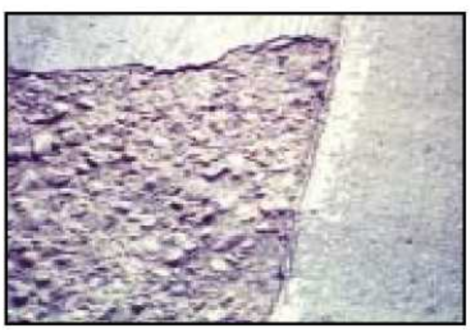

FIGURE 70
Distress Type JCP 8b—Scaling

FIGURE 71
Distress Type JCP 8b—Scaling, Close-up View

POLISHED AGGREGATE

Description

Surface mortar and texturing worn away to expose coarse aggregate.

Severity Levels

Not applicable. However, the degree of polishing may be reflected in a reduction of surface friction.

How to Measure

Record square meters of affected surface area.

NOTE: Diamond grinding also removes the surface mortar and texturing. However, this condition should not be recorded as polished aggregate, but instead, be noted by a comment.

FIGURE 72
Distress Type JCP 9—Polished Aggregate

POPOUTS

Description

Small pieces of pavement broken loose from the surface, normally ranging in diameter from 25 mm to 100 mm, and depth from 13 mm to 50 mm.

Severity Levels

Not applicable. However, severity levels can be defined in relation to the intensity of popouts as measured below.

How to Measure

Not recorded in LTPP surveys.

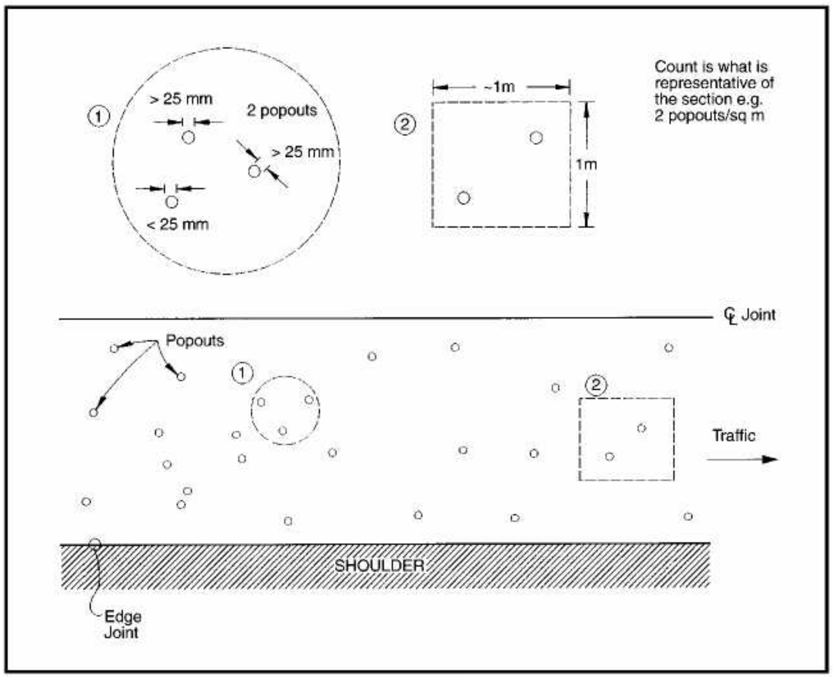

FIGURE 73
Distress Type JCP 10—Popouts

FIGURE 74
Distress Type JCP 10—A Popout

D

Miscellaneous Distresses

This section includes the following distresses:

11. Blowups
12. Faulting of Transverse Joints and Cracks
13. Lane-to-Shoulder Dropoff
14. Lane-to-Shoulder Separation
15. Patch/Patch Deterioration
16. Water Bleeding and Pumping

11

BLOWUPS

Description

Localized upward movement of the pavement surface at transverse joints or cracks, often accompanied by shattering of the concrete in that area.

Severity Levels

Not applicable. However, severity levels can be defined by the relative effect of a blowup on ride quality and safety.

How to Measure

Record the number of blowups.

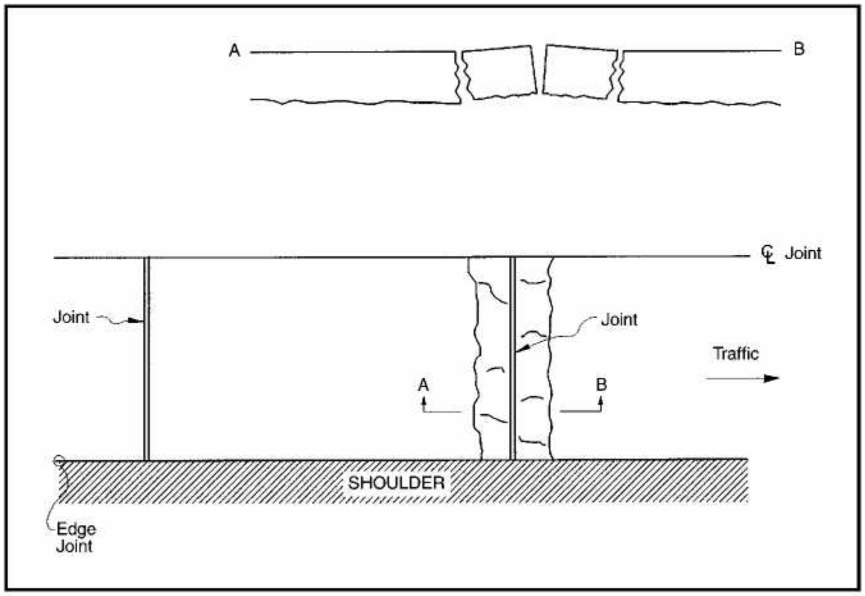

FIGURE 75
Distress Type JCP 11—Blowups

FIGURE 76
Distress Type JCP 11—A Blowup

JOINTED PORTLAND CEMENT CONCRETE SURFACES

FAULTING OF TRANSVERSE JOINTS AND CRACKS

Description

Difference in elevation across a joint or crack.

Severity Level

Not applicable. Severity levels could be defined by categorizing the measurements taken. A complete record of the measurements taken is much more desirable, however, because it is more accurate and repeatable than are severity levels.

How to Measure

Record in millimeters, to the nearest millimeter: 0.3 m and 0.75 m from the outside slab edge (approximately the outer wheel path). For a widened lane, the wheel path location will be 0.75 m from the outside lane edge stripe. At each location, three measurements are made, but only the approximate average of the readings is recorded.

If the "approach" slab is higher than the "departure" slab, record faulting as positive (+); if the approach slab is lower, record faulting as negative (-).

Faulting on PCC pavements is to be measured using a FHWA-modified Georgia Faultmeter. A representative reading from three distinct measurements at each location is to be used and recorded on sheet 6.

When anomalies such as patching, spalling, and corner breaks are encountered, the faultmeter should be offset to avoid the anomaly. The maximum offset is 0.3 m. A null value ("N") should be recorded and entered into the database when the surveyor is unable to take a measurement due to an anomaly.

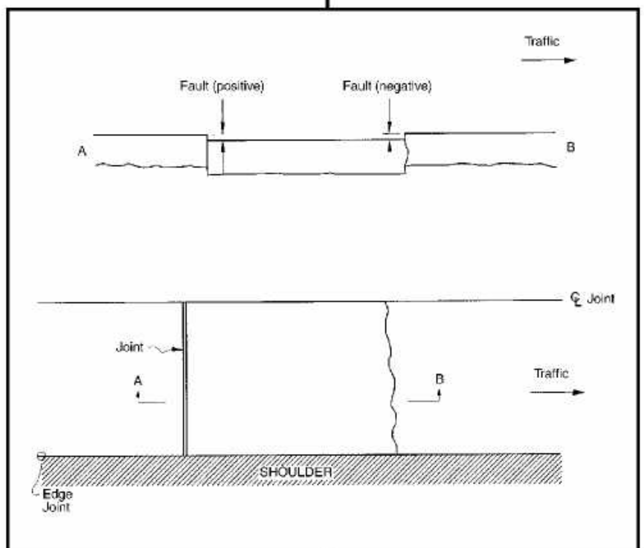

FIGURE 77
Distress Type JCP 12—Faulting of Transverse Joints and Cracks

Surveyors must ensure that they have a working faultmeter with fully charged batteries prior to beginning a survey on a jointed PCC test section. Complete faulting measurements and survey sheet 6 at the beginning of the distress survey to ensure that this data is collected.

Point distance measurements entered on sheet 6 for joints and transverse cracks should be consistent between surveys of the same test section to an accuracy of less than 0.5 m. Evaluate newly observed distresses and point distance differences for previously identified distresses of 0.5 m and greater with a metric tape measure. Note: The precise start point of surveys must be clearly identified in the field.

FIGURE 78
Distress Type JCP 12—Faulting of Transverse Cracks

LANE-TO-SHOULDER DROPOFF

Description

Difference in elevation between the edge of slab and outside shoulder; typically occurs when the outside shoulder settles.

Severity Levels

Not applicable. Severity levels can be defined by categorizing the measurements taken. A complete record of the measurements taken is much more desirable, however, because it is more accurate and repeatable than are severity levels.

How to Measure

Measure at the longitudinal construction joint between the lane edge and the shoulder.

Record to the nearest millimeter at 15.25-m intervals along the lane-to-shoulder joint.

If the traveled surface is lower than the shoulder, record as a negative (-) value.

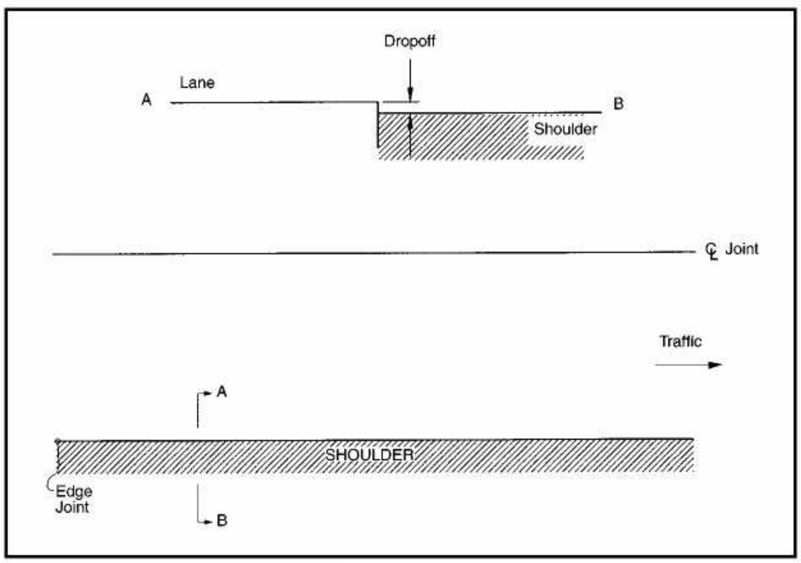

FIGURE 79
Distress Type JCP 13—
Lane-to-Shoulder Dropoff

FIGURE 80
Distress Type JCP 13—
Lane-to-Shoulder Dropoff

14

LANE-TO-SHOULDER SEPARATION

Description

Widening of the joint between the edge of the slab and the shoulder.

Severity Levels

Not applicable. Severity levels can be defined by categorizing the measurements taken. A complete record of the measurements taken is much more desirable, however, because it is more accurate and repeatable than severity levels.

How to Measure

Record to the nearest millimeter at intervals of 15.25 m along the lane-to-shoulder joint. Indicate whether the joint is well-sealed (yes or no) at each location.

Note: A null value ("N") should be recorded and entered into the database when the surveyor is unable to take a measurement due to an anomaly such as sealant or patch material.

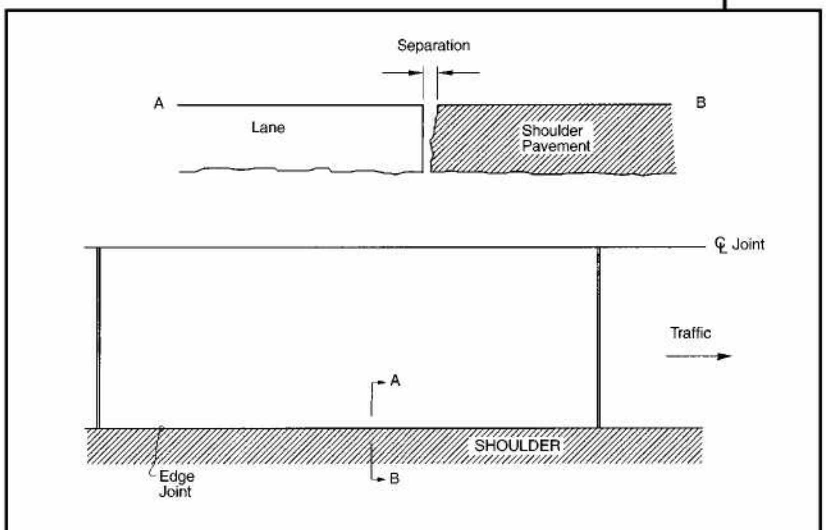

FIGURE 81
Distress Type JCP 14—Lane-to-Shoulder Separation

FIGURE 82
Distress Type JCP 14—Poorly Sealed Lane-to-Shoulder Separation

FIGURE 83
Distress Type JCP 14—Well-Sealed Lane-to-Shoulder Separation

15

PATCH/PATCH DETERIORATION

Description

A portion, greater than 0.1 m², or all of the original concrete slab that has been removed and replaced, or additional material applied to the pavement after original construction.

Severity Levels

LOW

Patch has low severity distress of any type; and no measurable faulting or settlement; pumping is not evident.

MODERATE

Patch has moderate severity distress of any type; or faulting or settlement up to 6 mm; pumping is not evident.

HIGH

Patch has a high severity distress of any type; or faulting or settlement ≥ 6 mm; pumping may be evident.

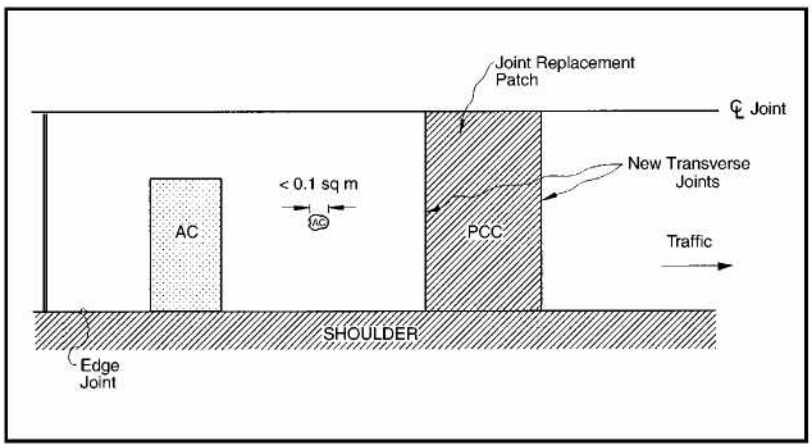

FIGURE 84
Distress Type JCP 15—Patch/Patch Deterioration

FIGURE 85
Distress Type JCP 15—Small, Low Severity Asphalt Concrete Patch

JOINTED PORTLAND CEMENT CONCRETE SURFACES

How to Measure

Record number of patches and square meters of affected surface area at each severity level, recorded separately by material type—rigid versus flexible. For slab replacement, rate each slab as a separate patch and continue to rate joints. Note: All patches meeting size criteria are rated.

FIGURE 86
Distress Type JCP 15—Large, Low Severity Asphalt Concrete Patch

FIGURE 87
Distress Type JCP 15—Large, High Severity Asphalt Concrete Patch

FIGURE 88
Distress Type JCP 15—Large, Low Severity Portland Cement Concrete Patch

16

WATER BLEEDING AND PUMPING

Description

Seeping or ejection of water from beneath the pavement through cracks. In some cases, detectable by deposits of fine material left on the pavement surface, which were eroded (pumped) from the support layers and have stained the surface.

Severity Levels

Not applicable. Severity levels are not used because the amount and degree of water bleeding and pumping changes with varying moisture conditions.

How to Measure

Record the number of occurrences of water bleeding and pumping and the length in meters of affected pavement with a minimum length of 1 m.

Note. The combined length of water bleeding and pumping cannot exceed the length of the test section.

FIGURE 89
Distress Type JCP 16—Water Bleeding and Pumping

This section covers continuously reinforced concrete-surfaced pavements (CRCP), including continuously reinforced concrete overlays on PCC pavements. Each of the distresses has been grouped into one of the following categories:

A. Cracking
B. Surface Defects
C. Miscellaneous Distresses

Table 3 summarizes the various types of distress and unit of measurement. Some distresses also have defined severity levels.

TABLE 3. Continuously Reinforced Concrete-Surfaced Pavement Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
A. Cracking / page **61**		
1. Durability Cracking ("D" Cracking)	Number, Square Meters	Yes
2. Longitudinal Cracking	Meters	Yes
3. Transverse Cracking	Number, Meters	Yes
B. Surface Defects / page **67**		
4a. Map Cracking	Number, Square Meters	No
4b. Scaling	Number, Square Meters	No
5. Polished Aggregate	Square Meters	No
6. Popouts	Not Measured	N/A
C. Miscellaneous Distress / page **71**		
7. Blowups	Number	No
8. Transverse Construction Joint Deterioration	Number	Yes
9. Lane-to-Shoulder Dropoff	Millimeters	No
10. Lane-to-Shoulder Separation	Millimeters	No
11. Patch/Patch Deterioration	Number, Square Meters	Yes
12. Punchouts	Number	Yes
13. Spalling of Longitudinal Joints	Meters	Yes
14. Water Bleeding and Pumping	Number, Meters	No
15. Longitudinal Joint Seal Damage	Number, Meters	No

A

Cracking

This section includes the following distresses:

1. Durability Cracking ("D" Cracking)
2. Longitudinal Cracking
3. Transverse Cracking

DURABILITY CRACKING ("D" CRACKING)

Description

Closely spaced, crescent-shaped hairline cracking pattern.

Occurs adjacent to joints, cracks, or free edges. Initiates at the intersection, e.g., cracks and a free edge.

Dark coloring of the cracking pattern and surrounding area.

Severity Levels

LOW
"D" cracks are tight, with no loose or missing pieces, and no patching is in the affected area.

MODERATE
"D" cracks are well-defined, and some small pieces are loose or have been displaced.

HIGH
"D" cracking has a well-developed pattern, with a significant amount of loose or missing material. Displaced pieces, up to 0.1 m², may have been patched.

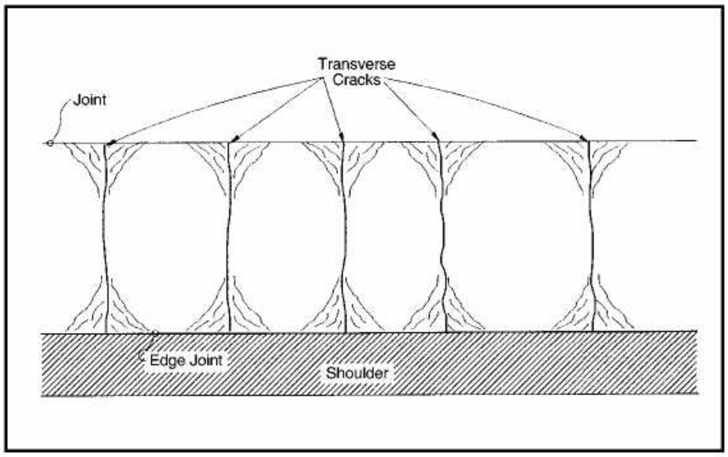

FIGURE 90
Distress Type CRCP 1—Durability Cracking ("D" Cracking)

How to Measure

Record number of affected transverse cracks at each severity level and the square meters of area affected at each severity level. The transverse crack and affected area severity rating is based on the highest severity level present for at least 10 percent of the area affected.

FIGURE 91
Distress Type CRCP 1—Moderate Severity "D" Cracking at Transverse Crack

FIGURE 92
Distress Type CRCP 1—High Severity "D" Cracking at Longitudinal Joint

LONGITUDINAL CRACKING

Description

Cracks that are predominantly parallel to the pavement centerline.

Severity Levels

LOW
Crack widths < 3 mm, no spalling, and there is no measurable faulting; or well-sealed and with a width that cannot be determined.

MODERATE
Crack widths ≥ 3 mm and < 13 mm; or with spalling < 75 mm; or faulting up to 13 mm.

HIGH
Crack widths ≥ 13 mm; or with spalling ≥ 75 mm; or faulting ≥ 13 mm.

How to Measure

Record length in meters of longitudinal cracking at each severity level. Also record length in meters of longitudinal cracking with sealant in good condition at each severity level.

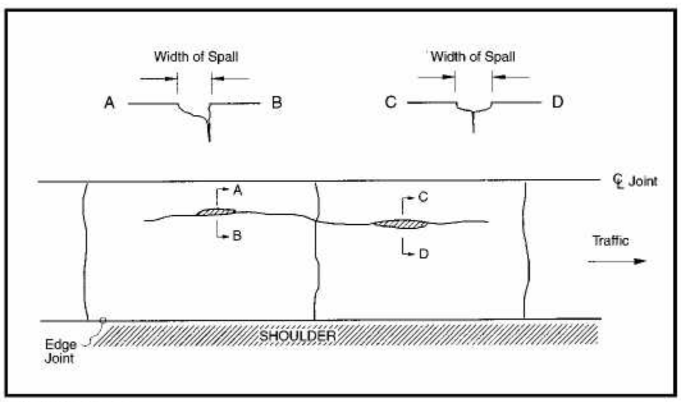

FIGURE 93
Distress Type CRCP 2—Longitudinal Cracking

Figure 94
Distress Type CRCP 2—Low Severity Longitudinal Cracking

FIGURE 95
Distress Type CRCP 2—High Severity Longitudinal Cracking

TRANSVERSE CRACKING

Description

Cracks that are predominantly perpendicular to the pavement centerline. This cracking is expected in a properly functioning CRCP. All transverse cracks that intersect an imaginary longitudinal line at midlane, and propagate from the pavement edges, shall be counted as individual cracks, as illustrated below. Cracks that do not cross midlane are not counted.

Severity Levels

LOW
Cracks that are not spalled or with spalling along ≤ 10 percent of the crack length.

MODERATE
Cracks with spalling along > 10 percent and ≤ 50 percent of the crack length.

HIGH
Cracks with spalling along > 50 percent of the crack length.

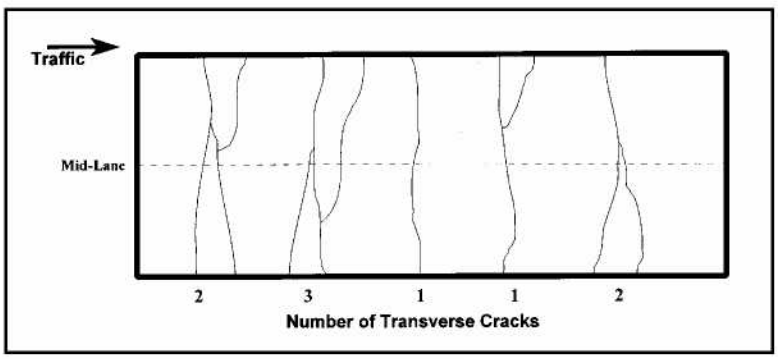

FIGURE 96
Distress Type CRCP 3—Transverse Cracking

FIGURE 97
Distress Type CRCP 3—Transverse Cracking Pattern

How to Measure

Record separately the number and length in meters of transverse cracking at each severity level. The sum of all the individual crack lengths shall be recorded. Then record the total number of transverse cracks within the survey section.

Note: Cracks that do not cross midlane, although not counted, should be drawn on the map sheets.

FIGURE 98
Distress Type CRCP 3—Low Severity Transverse Cracking

FIGURE 99
Distress Type CRCP 3—Moderate Severity Transverse Cracking

FIGURE 100
Distress Type CRCP 3—High Severity Transverse Cracking

B

Surface Defects

This section includes the following:

- **4a.** Map Cracking
- **4b.** Scaling
- **5.** Polished Aggregate
- **6.** Popouts

MAP CRACKING AND SCALING

4a. *MAP CRACKING*

Description

A series of cracks that extend only into the upper surface of the slab. Larger cracks frequently are oriented in the longitudinal direction of the pavement and are interconnected by finer transverse or random cracks.

Severity Levels

Not applicable.

How to Measure

Record the number of occurrences and the square meters of affected area. When an entire section is affected with map cracking, it should be considered one occurrence.

FIGURE 101
Distress Type CRCP 4a—Map Cracking Attributable to Alkali-Silica Reactivity

4b. *SCALING*

Description

Scaling is the deterioration of the upper concrete slab surface, normally 3 mm to 13 mm, and may occur anywhere over the pavement.

Severity Levels

Not applicable.

How to Measure

Record the number of occurrences and the square meters of affected area.

FIGURE 102
Distress Type CRCP 4b—Scaling

POLISHED AGGREGATE

Description

Surface mortar and texturing worn away to expose coarse aggregate.

Severity Levels

Not applicable. However, the degree of polishing may be reflected in a reduction of surface friction.

How to Measure

Record square meters of affected surface area.

NOTE: Diamond grinding also removes the surface mortar and texturing. However, this condition should not be recorded as polished aggregate but instead should be noted by a comment.

FIGURE 103
Distress Type CRCP 5—Polished Aggregate

POPOUTS

Description

Small pieces of pavement broken loose from the surface, normally ranging in diameter from 25 mm to 100 mm and depth from 13 mm to 50 mm.

Severity Levels

Not applicable. However, severity levels can be defined in relation to the intensity of popouts as measured below.

How to Measure

Not recorded in LTPP surveys.

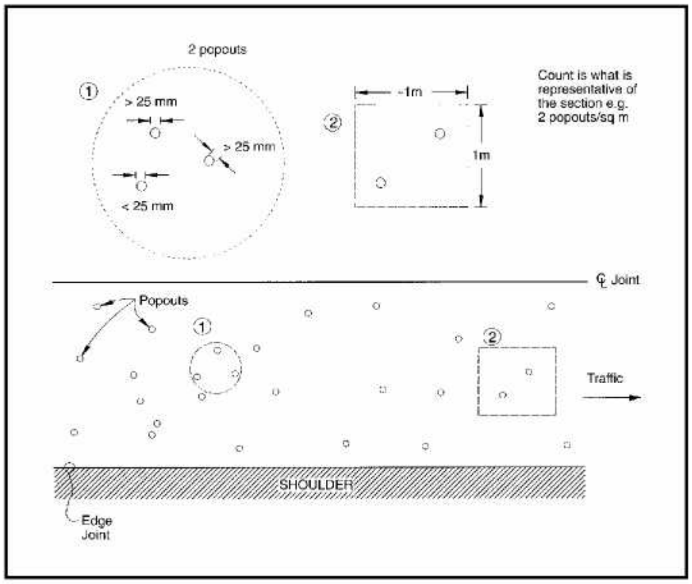

FIGURE 104
Distress Type CRCP 6—Popouts

FIGURE 105
Distress Type CRCP 6—Popouts

C

Miscellaneous Distresses

This section includes the following distresses:

7. Blowups
8. Transverse Construction Joint Deterioration
9. Lane-to-Shoulder Dropoff
10. Lane-to-Shoulder Separation
11. Patch/Patch Deterioration
12. Punchouts
13. Spalling of Longitudinal Joints
14. Water Bleeding and Pumping
15. Longitudinal Joint Seal Damage

7

BLOWUPS

Description

Localized upward movement of the pavement surface at transverse joints or cracks, often accompanied by shattering of the concrete in that area.

Severity Levels

Not applicable. However, severity levels can be defined by the relative effect of a blowup on ride quality and safety.

How to Measure

Record number of blowups.

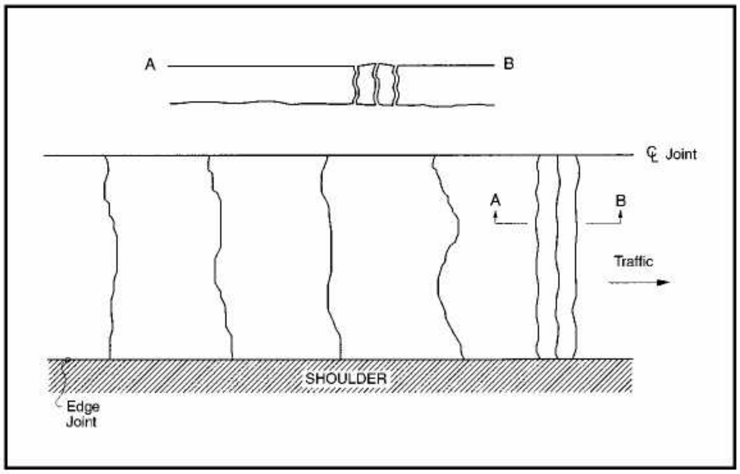

FIGURE 106
Distress Type CRCP 7—Blowups

FIGURE 108
Distress Type CRCP 7—Close-up View of a Blowup

FIGURE 107
Distress Type CRCP 7—A Blowup

FIGURE 109
Distress Type CRCP 7—Exposed Steel in a Blowup

CONTINUOUSLY REINFORCED CONCRETE SURFACES

TRANSVERSE CONSTRUCTION JOINT DETERIORATION

Description

Series of closely spaced transverse cracks or a large number of interconnecting cracks occurring near the construction joint.

Severity Levels

LOW
No spalling or faulting within 0.6 m of construction joint.

MODERATE
Spalling < 75 mm exists within 0.6 m of construction joint.

HIGH
Spalling ≥ 75 mm and breakup exists within 0.6 m of construction joint.

How to Measure

Record number of construction joints at each severity level.

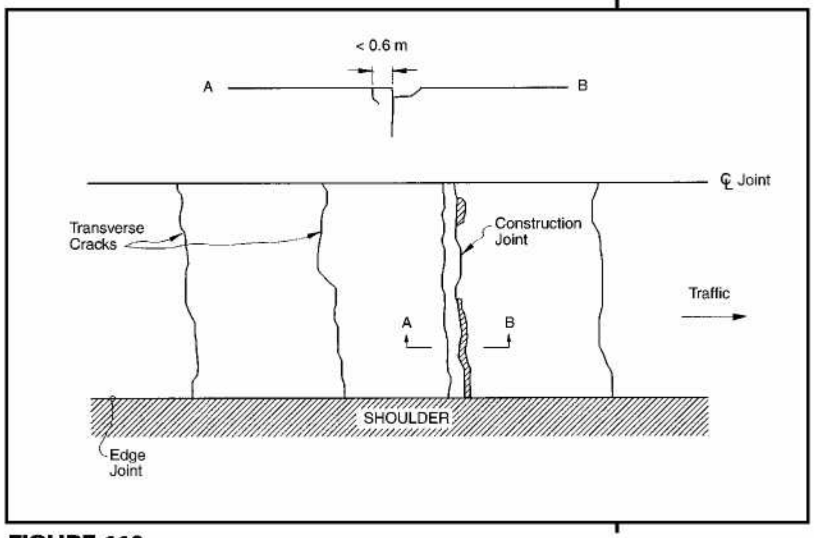

FIGURE 110
Distress Type CRCP 8—Transverse Construction Joint Deterioration

FIGURE 111
Distress Type CRCP 8—Low Severity Transverse Construction Joint Deterioration

FIGURE 112
Distress Type CRCP 8—Moderate Severity Transverse Construction Joint Deterioration

FIGURE 113
Distress Type CRCP 8—Low Severity Transverse Construction Joint Deterioration

9

LANE-TO-SHOULDER DROPOFF

Description

Difference in elevation between the edge of slab and outside shoulder; typically occurs when the outside shoulder settles.

Severity Levels

Not applicable. Severity levels could be defined by categorizing the measurements taken. A complete record of the measurements taken is much more desirable, however, because it is more accurate and repeatable than are severity levels.

How to Measure

Measure at the longitudinal construction joint between the lane edge and the shoulder.

Record in millimeters to the nearest millimeter at 15.25-m intervals along the lane-to-shoulder joint.

If the traveled surface is lower than the shoulder, record as a negative (-) value.

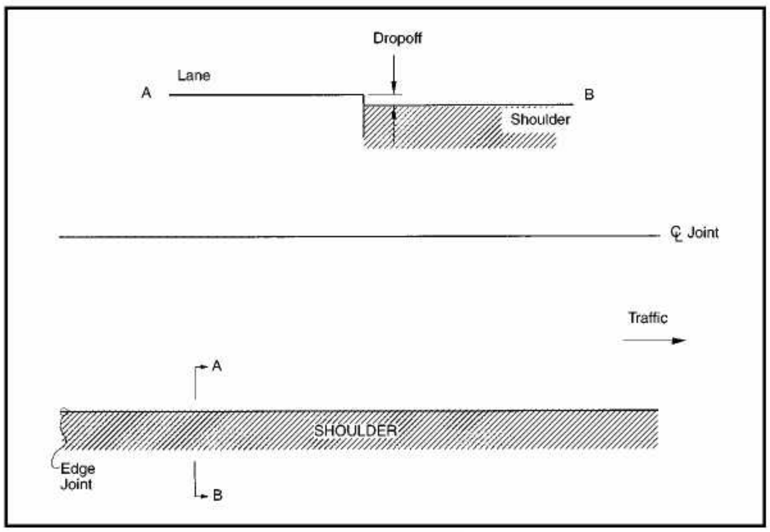

FIGURE 114
Distress Type CRCP 9—Lane-to-Shoulder Dropoff

FIGURE 115
Distress Type CRCP 9—Lane-to-Shoulder Dropoff

CONTINUOUSLY REINFORCED CONCRETE SURFACES

LANE-TO-SHOULDER SEPARATION

Description

Widening of the joint between the edge of the slab and the shoulder.

Severity Levels

Not applicable. Severity levels could be defined by categorizing the measurements taken. A complete record of the measurements taken is much more desirable, however, because it is more accurate and repeatable than are severity levels.

How to Measure

Record in millimeters to the nearest millimeter at intervals of 15.25 m along the lane-to-shoulder joint and indicate whether the joint is well-sealed (yes or no) at each location. Note: A null value ("N") should be recorded and entered into the database when the surveyor is unable to take a measurement due to an anomaly such as sealant or patch material.

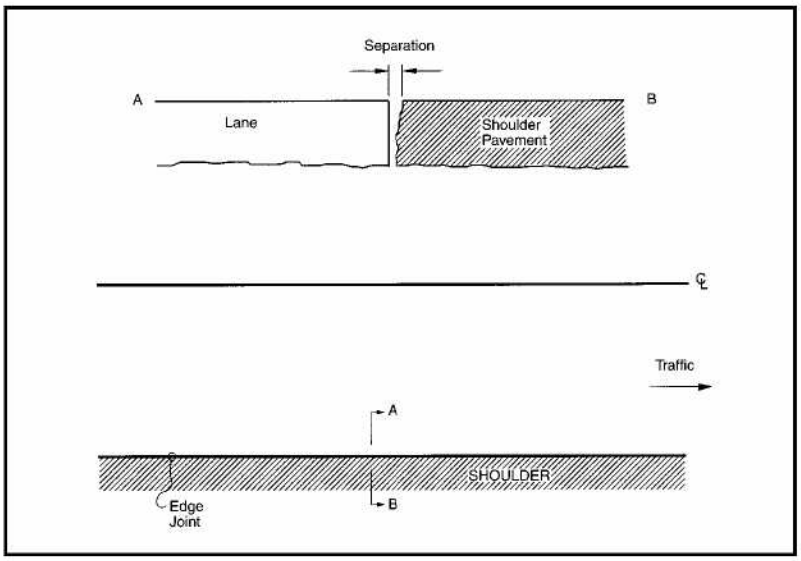

FIGURE 116
Distress Type CRCP 10—Lane-to-Shoulder Separation

FIGURE 117
Distress Type CRCP 10—Close-up View of a Lane-to-Shoulder Separation

PATCH/PATCH DETERIORATION

Description

A portion, greater than 0.1 m², or all of the original concrete slab that has been removed and replaced, or additional material applied to the pavement after original construction.

Severity Levels

LOW

Patch has, at most, low severity distress of any type; and no measurable faulting or settlement; pumping is not evident.

MODERATE

Patch has moderate severity distress of any type; or faulting or settlement up to 6 mm; pumping is not evident.

HIGH

Patch has a high severity distress of any type; or faulting or settlement ≥ 6 mm; pumping may be evident.

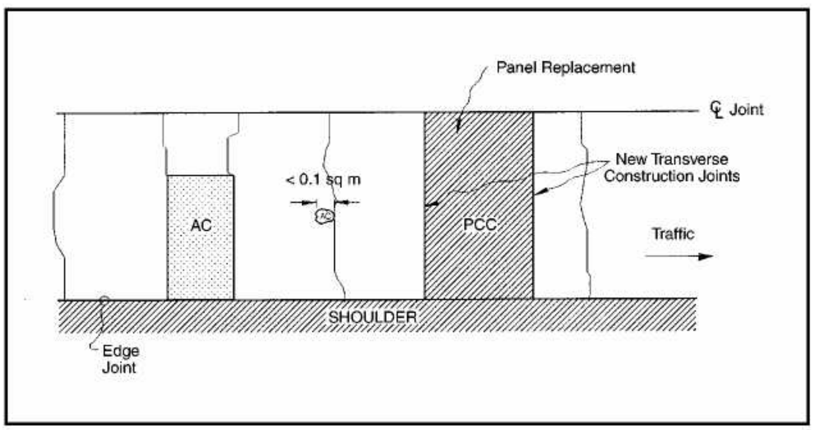

FIGURE 118
Distress Type CRCP 11—Patch/Patch Deterioration

FIGURE 119
Distress Type CRCP 11—Small, Low Severity Asphalt Concrete Patch

How to Measure

Record number of patches and square meters of affected surface area at each severity level, recorded separately by material type—rigid versus flexible.

Note: Panel replacement shall be rated as a patch. Any sawn joints shall be considered construction joints and rated separately. All patches are rated regardless of location.

FIGURE 120
Distress Type CRCP 11—Low Severity Asphalt Concrete Patch

FIGURE 121
Distress Type CRCP 11—Moderate Severity Asphalt Concrete Patch

FIGURE 122
Distress Type CRCP 11—Low Severity Portland Cement Concrete Patch

12

PUNCHOUTS

Description

The area enclosed by two closely spaced (usually < 0.6 m) transverse cracks, a short longitudinal crack, and the edge of the pavement or a longitudinal joint. Also includes "Y" cracks that exhibit spalling, breakup, or faulting.

Severity Levels

LOW

Longitudinal and transverse cracks are tight and may have spalling < 75 mm or faulting < 6 mm with no loss of material and no patching. Does not include "Y" cracks.

MODERATE

Spalling ≥ 75 mm and < 150 mm or faulting ≥ 6 mm and < 13 mm exists.

HIGH

Spalling ≥ 150 mm, or concrete within the punchout is punched down by ≥ 13 mm or is loose and moves under traffic or is broken into two or more pieces or contains patch material.

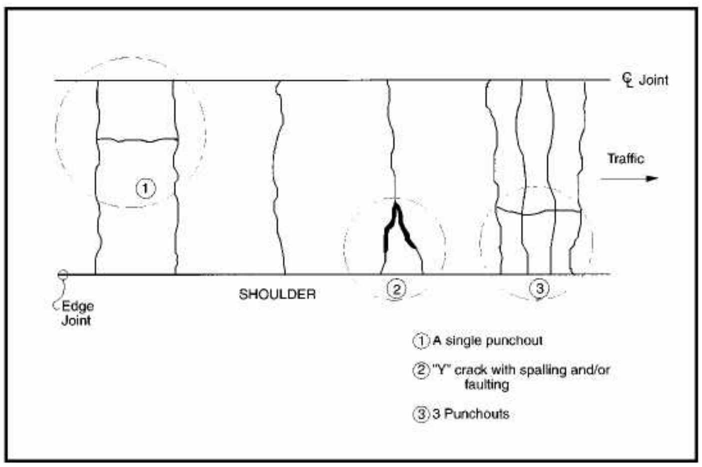

FIGURE 123
Distress Type CRCP 12—Punchouts

FIGURE 124
Distress Type CRCP 12—Low Severity Punchout

CONTINUOUSLY REINFORCED CONCRETE SURFACES

How to Measure

Record number of punchouts at each severity level.

The cracks which outline the punchout are also recorded under "Longitudinal Cracking" (CRCP 2) and "Transverse Cracking" (CRCP 3).

Punchouts that have been repaired by completely removing all broken pieces and replacing them with patching material (rigid or flexible) should be rated as a patch. If the boundaries of the punchout are visible, then also rate as a high severity punchout.

Note: Areas between two transverse cracks spaced greater than 0.6 m but less than or equal to 1 m apart, and bounded by the edge of pavement (or longitudinal joint) and a longitudinal crack, are rated as punchouts if the cracks are exhibiting spalling, or the area is breaking up or faulting.

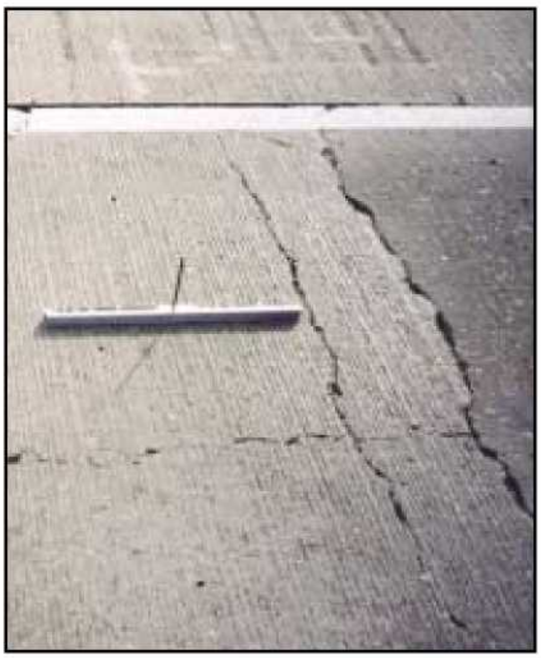

FIGURE 125
Distress Type CRCP 12—Moderate Severity Punchout

FIGURE 126
Distress Type CRCP 12—High Severity Punchout

SPALLING OF LONGITUDINAL JOINTS

Description

Cracking, breaking, chipping, or fraying of slab edges within 0.3 m of the longitudinal joint.

Severity Levels

LOW

Spalls < 75 mm wide, measured to the face of the joint, with loss of material or spalls with no loss of material and no patching.

MODERATE

Spalls 75 mm to 150 mm wide, measured to the face of the joint, with loss of material.

HIGH

Spalls > 150 mm wide measured to the face of the joint, with loss of material or is broken into two or more pieces or contains patch material.

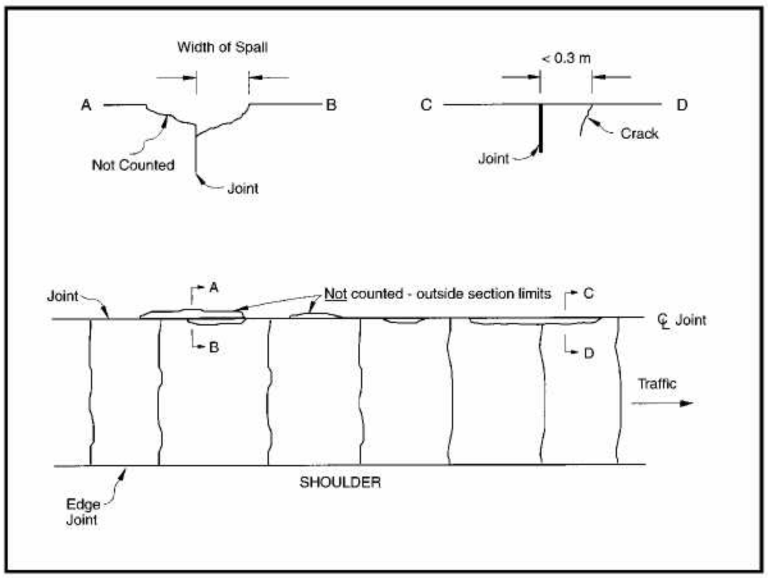

FIGURE 127
Distress Type CRCP 13—Spalling of Longitudinal Joints

How to Measure

Record length in meters of longitudinal joint spalling at each severity level. Only record spalls having a length of 0.1 m or more. Spalls that have been repaired by completely removing all broken pieces and replacing them with patching material (rigid or flexible) should be rated as a patch. If the boundaries of the spall are visible, then also rate as a high severity spall.

Note: All patches meeting size criteria are rated as patches.

FIGURE 128
Distress Type CRCP 13—Close-up View of Low Severity Spalling of a Longitudinal Joint

FIGURE 129
Distress Type CRCP 13—Low Severity Spalling of a Longitudinal Joint

FIGURE 130
Distress Type CRCP 13—Moderate Severity Spalling of a Longitudinal Joint

14

WATER BLEEDING AND PUMPING

Description

Seeping or ejection of water from beneath the pavement through cracks or joints. In some cases detectable by deposits of fine material left on the pavement surface, which were eroded (pumped) from the support layers and have stained the surface.

Severity Levels

Not applicable. Severity levels are not used because the amount and degree of water bleeding and pumping changes with varying moisture conditions.

How to Measure

Record the number of occurrences of water bleeding and pumping and the length in meters of affected pavement with a minimum length of 1 m.

Note: The combined quantity of water bleeding and pumping cannot exceed the length of the test section.

FIGURE 131
Distress Type CRCP 14—Water Bleeding and Pumping

FIGURE 132
Distress Type CRCP 14—Close-up View of Water Bleeding and Pumping

LONGITUDINAL JOINT SEAL DAMAGE

15

Description

Joint seal damage is any condition that enables incompressible materials or a significant amount of water to infiltrate into the joint from the surface. Typical types of joint seal damage are:

Extrusion, hardening, adhesive failure (bonding), cohesive failure (splitting), or complete loss of sealant.

Intrusion of foreign material in the joint.

Weed growth in the joint.

Severity Levels

Not applicable.

How to Measure

Record number of longitudinal joints that are sealed (0, 1, 2). Record length of sealed longitudinal joints with joint seal damage as described above. Individual occurrences are recorded only when at least 1 m in length.

FIGURE 133
Distress Type CRCP 15—Longitudinal Joint Seal Damage

TABLE OF CONTENTS

A

MANUAL FOR DISTRESS SURVEYS

INTRODUCTION

This appendix provides instructions, data sheets, and distress maps for use in visual surveys for the collection of distress information for ACP, JCP, and CRCP surfaces. Visual distress survey procedures have been used in the LTPP program as the primary distress data collection method since 1995. The *Distress Identification Manual for the Long-Term Pavement Performance Program* is the basis for all distress surveys performed for the LTPP.

During the visual distress survey, safety is the first consideration, as with all field data collection activities. All raters must adhere to the practices and authority of the State or Canadian Province.

EQUIPMENT FOR DISTRESS SURVEYS

The following equipment is necessary for performing field distress surveys of any pavement surface type.

- Copy of map sheets and survey forms from most recent prior survey.
- Pavement thermometer.
- Extra blank data sheets and maps.
- Pencils.
- Latest version of the *Distress Identification Manual.*
- Clipboard.
- Two tape measures, one at least 30 m long and a scale or ruler graduated in millimeters.
- Calculator.
- Hard hat or safety cap and safety vest.
- Faultmeter, calibration stand and manual for PCC test sections.
- Digital camera, video camera, tapes.
- Transverse profile equipment required for AC test sections.
- Longitudinal profile equipment is required on sites where the LTPP Profilometer is unable to test.

INSTRUCTIONS FOR COMPLETING DISTRESS MAPS

The distress maps show the exact location of each distress type existing on the test section. The distress types and severity levels should be identified by using the *Distress Identification Manual.* A total of five sheets are used to map; each sheet contains two 15.25-m maps which represent 30.5 m of the test section (with the exception of SPS-6 sections 2 and 5, which are 305 m).

Each test section must be laid out consistently each time a survey is conducted. Sections begin and end at the stations marked on the pavement. Lateral extent of the section, for survey purposes, will vary depending on the existence of longitudinal joints and cracks and the relative position of the lane markings. Figures A1 and A2 illustrate the rules to follow when determining the lateral extent of the section for a distress survey. The lateral extent of the test sections should be consistent with prior distress surveys. On widened PCC sections, the lateral extent of the test section includes the full width (4.3 m) of the slab measured from the centerline longitudinal joint to the shoulder joint. The lateral extent of AC test sections with double yellow lines on the centerline are determined by using the inside yellow line.

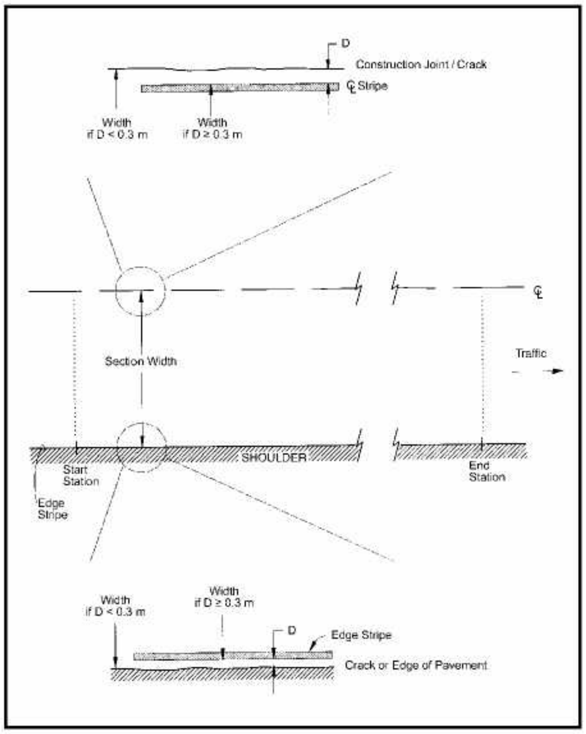

FIGURE A1
Test Section Limits for Surveys—Asphalt Surface

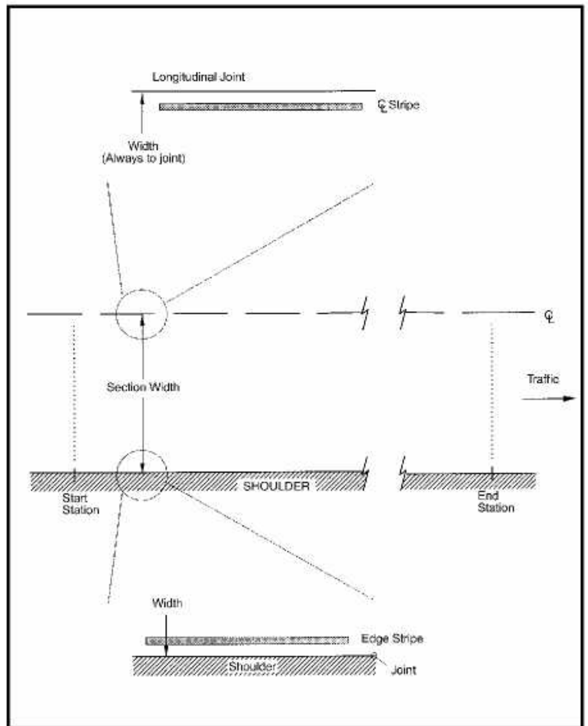

FIGURE A2
Test Section Limits for Surveys—Concrete Surface

To map the test section, place the tape measure on the shoulder adjacent to the test section from Station 0+00 to Station 1+00. It may be necessary to secure the tape onto the pavement with adhesive tape or a heavy object. After the tape is in place, the distresses can be mapped with the longitudinal placement of the distresses read from the tape. The transverse placement and extent of the distresses can be recorded using the additional tape measure. After the first 30.5-m subsection is mapped, the tape measure should be moved to map the second 30.5-m subsection. The process is repeated throughout the test section.

The distresses are drawn on the map at the scaled location using the symbols appropriate to the pavement type. In general, the distress is drawn and is labeled using the distress type number and the severity level (L, M, or H) if applicable. For example, a high severity longitudinal crack in the wheel path of an ACP would be labeled "4aH." An additional symbol is added beside the distress type and severity symbol in cases where the crack or joint is well-sealed. Figures specifying the symbols to be used for each pavement type are presented in the following chapters. In addition, example maps are provided to illustrate properly completed maps.

Any observed distresses that are not described in the *Distress Identification Manual* should be photographed and described on the comments line of the map sheet. The location and extent of the distress should be shown and labeled on the map. Crack sealant and joint sealant condition is to be mapped only for those distresses indicated in figures A4, A5, and A8. The specific distress types that are not to be included on the maps are to be recorded as follows:

Asphalt Concrete-Surfaced Pavement

If raveling, polished aggregate, or bleeding occur in large areas over the test section, do not map the total extent. Instead, note the location and extent in the space for comments underneath the appropriate map(s). These distresses should be mapped only if they occur in localized areas. The extent of these distresses must be summarized on the data summary sheets.

Jointed Concrete Pavement and Continuously Reinforced Concrete Pavement

If map cracking/scaling, or polished aggregate occur in large areas over the test section, do not map the total extent. Instead, note the location, extent, and severity level if applicable in the space for comments underneath the appropriate map(s). These distresses should be mapped only if they occur in localized areas. The extent of these distresses must be summarized on the data summary sheets.

SURVEY SHEETS' DATA ELEMENTS

In the common data section appearing in the upper right-hand corner of each of the distress survey data sheets the six-digit SHRP ID (two-digit State code plus four-digit SHRP Section ID) is entered. The date the survey was conducted, the initials of up to three raters, before and after pavement surface temperature readings, and the code indicating whether photographs and/or video tape were obtained at the time of the survey are entered in the appropriate spaces.

INSTRUCTIONS FOR COMPLETING ACP DISTRESS SURVEY SHEETS

Location of the vehicle wheel paths is critical for distinguishing between types of longitudinal cracking in ACP. Figure A3 illustrates the procedure for establishing the location and extent of the wheel paths. Both wheel paths must be drawn and identified on the distress maps. The distresses observed are recorded to scale on map sheets. The individual distresses and severity levels depicted on the map are carefully scaled and summed to arrive at the appropriate quantities (e.g., square meters or number of occurrences) and are then recorded on sheets 1-3. It is important to carefully evaluate the distress

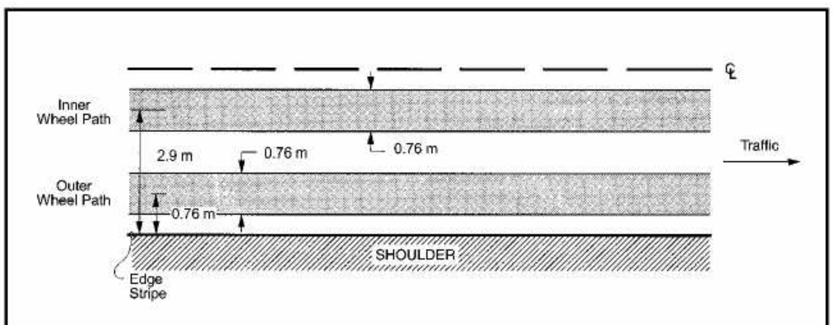

FIGURE A3
Locating Wheel Paths in Asphalt Concrete-Surfaced Pavements

map for certain distress types which have multiple methods of measurement because of orientation or location within the section. Longitudinal cracking, in the wheel path or elsewhere, are examples of these. Except where indicated otherwise, entries are made for all distress data elements. If a particular type of distress does not exist on the pavement, enter "0" as a positive indication that the distress was not overlooked in summarizing the map sheets. All data sheets are to be completed in the field prior to departing the site. Symbols to be used for mapping ACP sections are contained in figure A4, and an example mapped section is shown in figure A5.

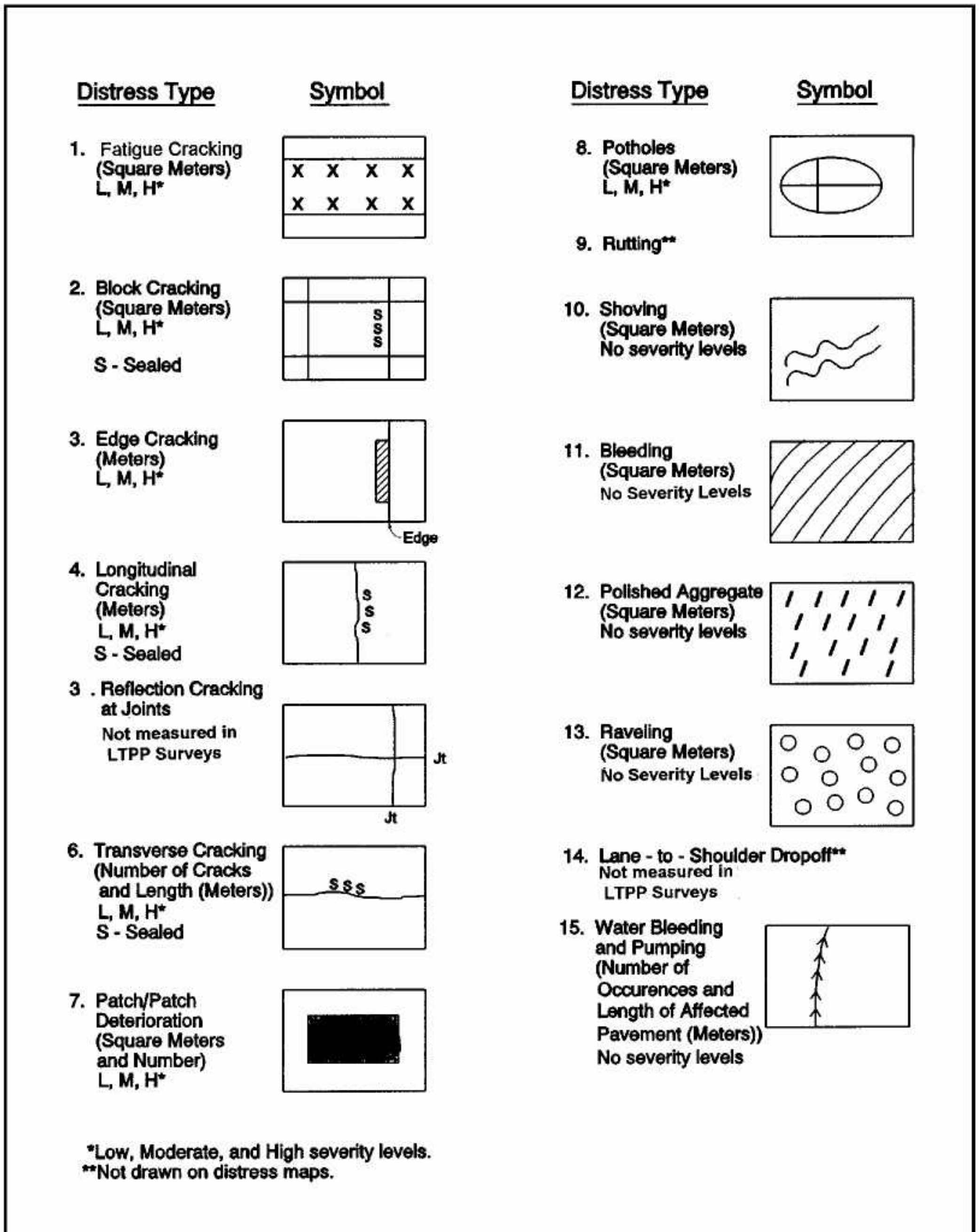

FIGURE A4
Distress Map Symbols for Asphalt Concrete-Surfaced Pavements

Appendix A

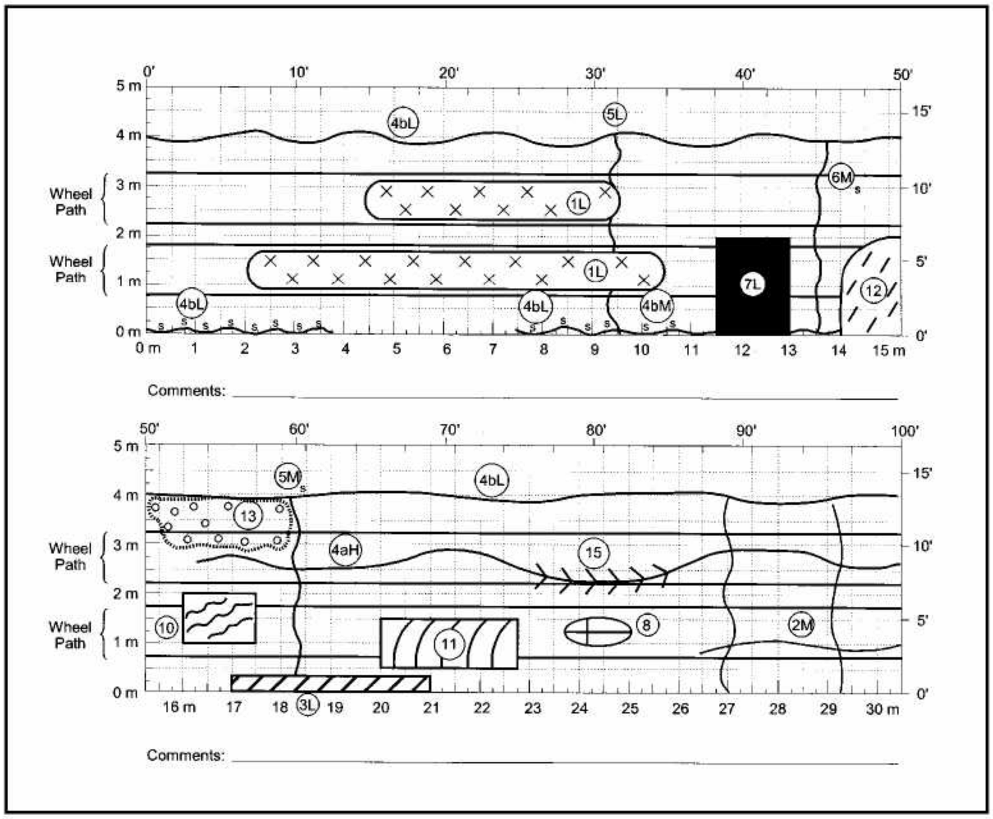

FIGURE A5
Example Map of First 30.5 meters of Asphalt Concrete Pavement Section

Description of Data Sheet 1

This data sheet provides space for recording measured values for the distress types identified in the left column. The units of measurement for each of the distress types are also identified in the left column. The extent of the measured distress for each particular level of severity is entered in the severity level columns identified as low, moderate, or high. Enter "0" for any distress types and/or severity levels not found.

Description of Data Sheet 2

This sheet is a continuation of the distress survey data recorded on sheet 1 and is completed as described under data sheet 1. In addition, space is provided to list "Other" distress types found on the test section but not listed on data sheets 1 or 2.

Description of Data Sheet 3

This data sheet provides space to record rutting (using a straight edge 1.2 m long). Manual rutting measurements using a straight edge are only taken for visual surveys conducted on SPS-3 experiment sections. Measurements are taken at the beginning of the test section and at 15.25 m intervals. There should be a total of 11 measurements in each wheel path, for a total of 22 measurements on each test section.

INSTRUCTIONS FOR COMPLETING JCP DATA SHEETS

The distresses observed are recorded to scale on map sheets. This information is reduced by the rater in the field to summarize the results, which are then recorded on sheets 4-7. Except where indicated otherwise, entries are made for all distress data elements. If a particular type of distress does not exist on the pavement, enter "0" as a positive indication that the distress was not overlooked in summarizing the map sheets. Symbols to be used for mapping distresses in JCP sections are shown in figure A6, and an example mapped section is presented in figure A7.

Description of Data Sheet 4

This data sheet provides space for recording measured values for the distress types identified in the left column. The units of measurement for each of the distress types are also identified in the left column. The extent of the measured distress for each particular level of severity is entered in the severity level columns identified as low, moderate, or high. Enter "0" for any distress types and/or severity levels not found. The distress types and severity levels should be identified by using the *Distress Identification Manual.*

Description of Data Sheet 5

This sheet is a continuation of the distress survey data recorded on sheet 4 and is completed as described under data sheet 4. In addition, space is provided to list "Other" distress types found on the test section but not listed on data sheets 4 or 5.

Description of Data Sheet 6

This data sheet provides space to record faulting information for each transverse joint and transverse crack. Distance from the beginning of the section, and faulting measurements made at two transverse locations, are recorded. The transverse locations are 0.3 m and 0.75 m from the outside edge of the slab. For widened lanes, measure 0.3 m from the edge of the slab and 0.75 m from the outside edge of the lane edge stripe. At each location, three measurements are made, but only the approximate average of the readings is recorded to the nearest millimeter.

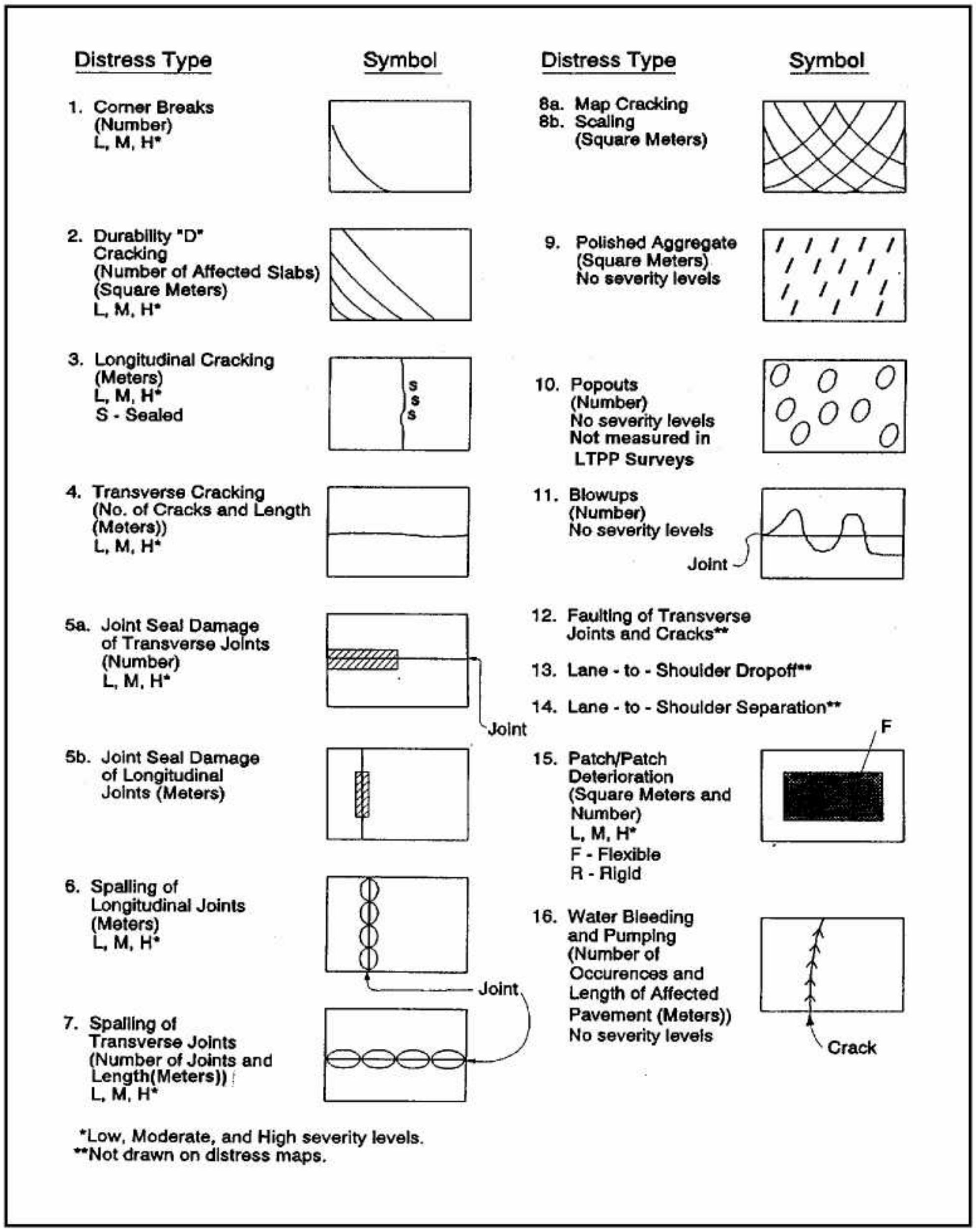

FIGURE A6
Distress Map Symbols for Jointed Concrete Pavements

Although no field is provided in the space to the left of the entry for measured faulting, there is room for a negative sign when negative faulting is observed. If the "approach" slab is higher than the "departure" slab, a positive sign is assumed, but no entry is required. If the "approach" slab is lower, a negative sign is entered.

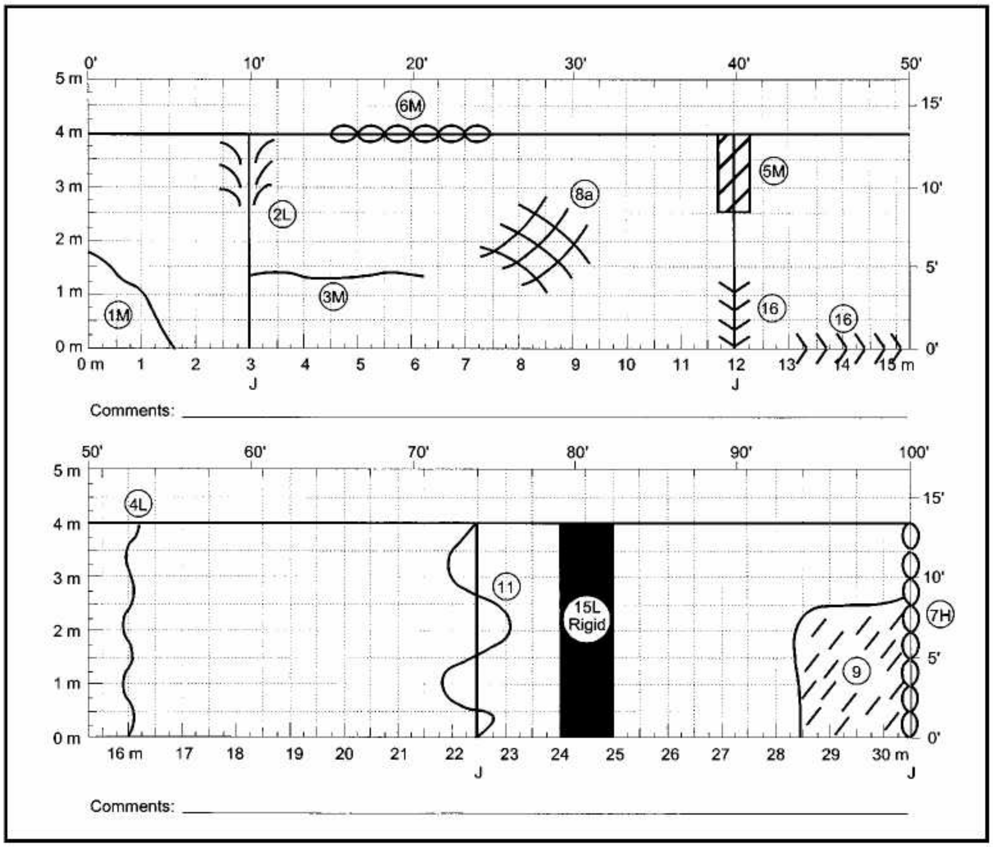

FIGURE A7
Example Map of First 30.5 meters of a Jointed Concrete Pavement Section

Description of Data Sheet 7

This sheet is used to record lane-to-shoulder dropoff and lane-to-shoulder separation. Lane-to-shoulder dropoff is measured as the difference in elevation, to the nearest 1 mm, between the pavement surface and the adjacent shoulder surface. Measurements are taken at the beginning of the test section and at 15.25-m intervals (a total of 11 measurements) at the lane/shoulder interface or joint. Lane-to-shoulder dropoff typically occurs when the outside shoulder settles. However, heave of the shoulder may occur due to frost action or swelling soil. If heave of the shoulder is present, it should be recorded as a negative value. At each point where there is no lane-to-shoulder dropoff, enter "0."

Lane-to-shoulder separation is measured as the width of the joint (to the nearest 1 mm) between the outside lane and the adjacent shoulder surface. Measurements are taken at the beginning of the test section and at 15.25-m intervals (a total of 11 measurements). At each point where there is no lane-to-shoulder separation, enter "0." When the surveyor is unable to take a measurement due to an anomaly such as sealant or patch material, a null value ("N") should be recorded and entered into the database.

INSTRUCTIONS FOR COMPLETING CRCP DATA SHEETS

The results of distress surveys on CRCP surfaces are recorded on sheets 8-10. Except where indicated otherwise, entries are made for all distress data elements. If a particular type of distress does not exist on the pavement, enter "0" as a positive indication that the distress was not overlooked in summarizing the map sheets. All data sheets are to be completed in the field prior to departing the site. Symbols to be used for mapping CRCP distresses are contained in figure A8 and an example mapped section is presented in figure A9.

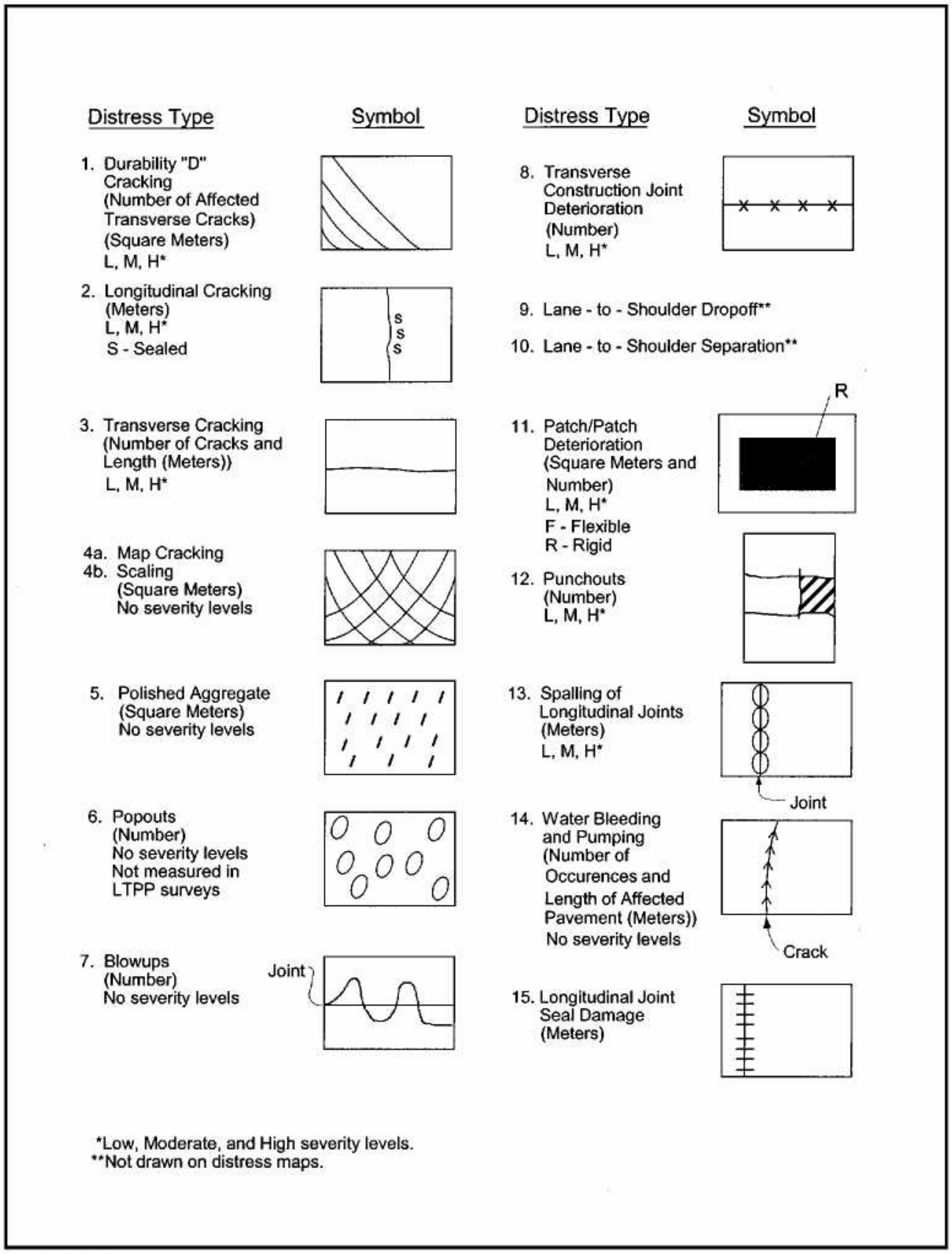

FIGURE A8

Distress Map Symbols for Continuously Reinforced Concrete Pavements

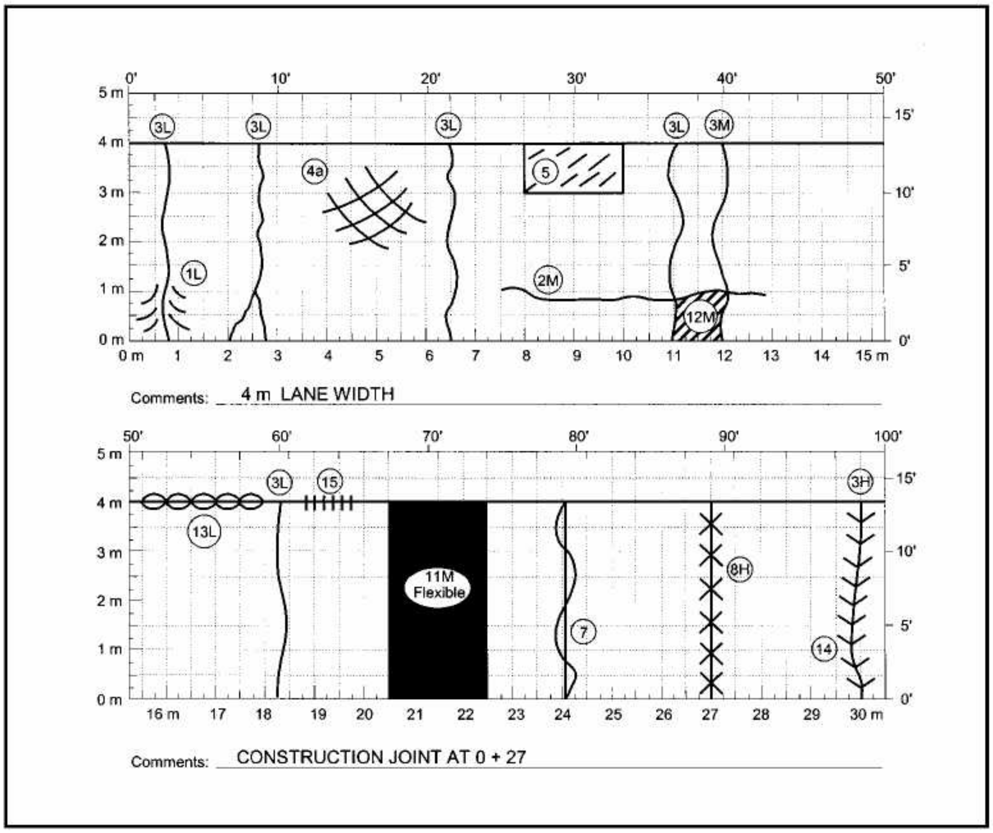

FIGURE A9
Example Map of First 30.5 meters of a Continuously Reinforced Concrete Pavement Section

Description of Data Sheet 8

This data sheet provides space for recording measured values for the distress types identified in the left column. The units of measurement for each of the distress types are also identified in the left column. The extent of the measured distress for each particular level of severity is entered in the severity level columns identified as low, moderate, or high, except as indicated on the form. Enter "0" for any distress types and/or severity levels not found. The distress types and severity levels should be identified by using the *Distress Identification Manual.*

Description of Data Sheet 9

This sheet is a continuation of the distress survey data recorded on sheet 8 and is completed as described under data sheet 9. In addition, space is provided to list "Other" distress types found on the test section but not listed on data sheets 8 or 9.

Description of Data Sheet 10

This data sheet provides space to record lane-to-shoulder dropoff and lane-to-shoulder separation. Measurements are taken at the beginning of the test section and at 15.25-m intervals (a total of 11 measurements for each distress) at the lane/shoulder interface or joint.

Lane-to-shoulder dropoff is measured as the difference in elevation (to the nearest 1 mm) between the pavement surface and the adjacent shoulder surface. Lane-to-shoulder dropoff typically occurs when the outside shoulder settles. However, heave of the shoulder may occur due to frost action or swelling soil. If heave of the shoulder is present, it should be recorded as a negative (-) value.

Lane-to-shoulder separation is measured as the width of the joint (to the nearest 1 mm) between the outside lane and the adjacent shoulder surface.

When the surveyor is unable to take a measurement due to an anomaly such as a sealant or patch material, a null value ("N") is recorded and entered into the database.

At each point where there is no lane-to-shoulder dropoff or lane-to-shoulder separation, enter "0."

Example Survey Maps and Completed Sheets

This part of the appendix shows completed maps and survey forms for a JCP 60 m in length. The rater uses the definitions from the *Distress Identification Manual* and the symbols from this appendix when mapping the section. The rater then quantifies each distress (and severity levels for the appropriate distresses) on the map. The rater then uses the right margin of the map sheets to tally the quantities of each distress type. This method is required because it simplifies totaling the various distress types, and reduces errors. The rater then uses the tallies from each map sheet to add the distress quantities. The section totals are entered in the left margin of the first map sheet.

The rater then writes in the totals in the appropriate blanks on the survey forms. All blanks are filled in. Zeros are entered if no distress was found. These forms provide a summary of the distresses found in the JCP section.

SHEET 4

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/ DAY/YEAR) __ __/ __ __/ __ __
SURVEYORS: __ __ __, __ __ __, __ __ __
PAVEMENT SURFACE TEMP - BEFORE __ __ __ __°C; AFTER__ __ __ __°C
PHOTOS, VIDEO, OR BOTH WITH SURVEY (P,V,B) __

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	__ __ __	__ __ __	__ __ __
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	__ __ __	__ __ __	__ __ __
AREA AFFECTED (Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
3. LONGITUDINAL CRACKING (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Length Sealed (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
4. TRANSVERSE CRACKING (Number of Cracks)	__ __ __	__ __ __	__ __ __
(Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Length Sealed (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
JOINT DEFICIENCIES			
5a. TRANSVERSE JOINT SEAL DAMAGE			
Sealed (Y, N)			__
If "Y" Number of Joints	__ __	__ __	__ __
5b. LONGITUDINAL JOINT SEAL DAMAGE			
Number of Longitudinal Joints that have been sealed (0, 1, or 2)			__
Length of Damaged Sealant (Meters)			__ __ __.__
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
7. SPALLING OF TRANSVERSE JOINTS			
Number of Affected Joints	__ __	__ __	__ __
Length Spalled (Meters)	__ __ __.__	__ __ __.__	__ __ __.__

SHEET 5

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DATE OF DISTRESS SURVEY (MONTH/ DAY/ YEAR) __ __/ __ __/ __ __

SURVEYORS: __ __ __, __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
8a. MAP CRACKING (Number)			__ __ __
(Square Meters)			__ __ __.__
8b. SCALING (Number)			__ __ __
(Square Meters)			__ __ __.__
9. POLISHED AGGREGATE (Square Meters)			__ __ __.__
10. POPOUTS Not Recorded			
MISCELLANEOUS DISTRESSES			
11. BLOWUPS (Number)			__ __ __
12. FAULTING OF TRANSVERSE JOINTS AND CRACKS - REFER TO SHEET 6			
13. LANE-TO-SHOULDER DROP-OFF - REFER TO SHEET 7			
14. LANE-TO-SHOULDER SEPARATION - REFER TO SHEET 7			
15. PATCH/ PATCH DETRIORATION			
Flexible			
(Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Rigid			
(Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
16. WATER BLEEDING AND PUMPING (Number of occurrences)			__ __ __
Length Affected (Meters)			__ __ __.__
17. OTHER (Describe) ______________________________			

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DATE OF DISTRESS SURVEY (MONTH/ DAY/ YEAR) __ __/ __ __/ __ __

SURVEYORS: __ __ __, __ __ __

FAULTMETER NO. ____________

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Point[1] Distance (Meters)	J / C	Faulting[2], mm 0.3m	0.75m	Point[1] Distance (Meters)	J / C	Faulting[2], mm 0.3m	0.75m
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _
_ _ _._	_	_ _ _	_ _ _	_ _ _._	_	_ _ _	_ _ _

Note 1. Point Distance is from the start from the test section to the measurement location.

Note 2. If the approach slab is higher than the departure slab, faulting is recorded as positive (+ or 0); if the approach slab is lower, record faulting as negative (-) and the minus sign must be used.

SHEET 7

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DATE OF DISTRESS SURVEY (MONTH/ DAY/ YEAR) __ __/ __ __/ __ __

SURVEYORS: __ __ __, __ __ __

FAULTMETER NO. ____________

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

13. LANE-TO-SHOULDER DROP-OFF

14. LANE-TO-SHOULDER SEPARATION

Point No.	Point[1] Distance (Meters)	Lane-to-shoulder[2] Dropoff (mm)	Lane-to-shoulder Separation (mm)	Well Sealed (Y/N)
1.	0.0	__ __ __	__ __ __	__
2.	15.25	__ __ __	__ __ __	__
3.	30.5	__ __ __	__ __ __	__
4.	45.75	__ __ __	__ __ __	__
5.	61.0	__ __ __	__ __ __	__
6.	76.25	__ __ __	__ __ __	__
7.	91.5	__ __ __	__ __ __	__
8.	106.75	__ __ __	__ __ __	__
9.	122.0	__ __ __	__ __ __	__
10.	137.25	__ __ __	__ __ __	__
11.	152.5	__ __ __	__ __ __	__

Note 1. Point Distance is from the start of the test section to the measurement location. The values shown are S1 equivalents of the 50ft spacing used in previous surveys.

Note 2. If heave of the shoulder occurs (upward movement), record as a negative (-) value. Do not record (+) signs, positive values are assumed.

SHEET 8

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) __ __/ __ __/ __ __

SURVEYORS: __ __ __, __ __ __ PHOTOS,VIDEO,OR BOTH WITH SURVEY (P,V,B) __

PAVEMENT SURFACE TEMP - BEFORE __ __ __ __°C; AFTER __ __ __ __°C

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. DURABILITY "D"CRACKING			
(No. of affected Trans Cracks)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
2. LONGITUDINAL CRACKING (Meters)	__ __ __ __	__ __ __.__	__ __ __.__
Length Well Sealed (Meters)	__ __ __ __	__ __ __.__	__ __ __.__
3. TRANSVERSE CRACKING			
(Total Number of Cracks)			__ __ __
(Number of Cracks)	__ __ __	__ __ __	__ __ __
(Meters)	__ __ __.__	__ __ __.__	__ __ __.__
SURFACE DEFECTS			
4a. MAP CRACKING (Number)			__ __ __
(Square Meters)			__ __ __.__
4b. SCALING (Number)			__ __ __
(Square Meters)			__ __ __.__
5. POLISHED AGGREGATE (Square Meters)			__ __ __.__
6. POPOUTS Not Recorded			

SHEET 9

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DATE OF DISTRSS SURVEY (MONTH/ DAY/ YEAR) __ __/ __ __/ __ __
SURVEYORS: __ __ __, __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
MISCELLANEOUS DISTRESSES			
7. BLOWUPS (Number)			__ __ __
8. TRANSVERSE CONSTRUCTION JOINT DETERIORATION (Number)	__ __	__ __	__ __
9. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 10			
10. LANE-TO-SHOULDER SEPARATION - REFER TO SHEET 10			
11. PATCH/ PATCH DETERIORATION			
Flexible			
(Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Rigid			
(Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
12. PUNCHOUTS (Number)	__ __	__ __	__ __
13. SPALLING OF LONGITUDINAL JOINT (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
14. WATER BLEEDING AND PUMPING			
(Number of Occurrences)			__ __ __
Length Affected (Meters)			__ __ __.__
15. LONGITUDINAL JOINT SEAL DAMAGE			
Number of Longitudinal Joints that have been sealed (0, 1, or 2)			__
If Sealed Length w/ Damaged Sealant (Meters)			__ __ __.__

16. OTHER (Describe) ____________________

____

____

SHEET 10

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DATE OF DISTRESS SURVEY (MONTH/ DAY/ YEAR) __ __/ __ __/ __ __

SURVEYORS: __ __ __, __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

9. LANE-TO-SHOULDER DROPOFF

10. LANE-TO-SHOULDER SEPARATION

Point No.	Point[1] Distance (Meters)	Lane-to-Shoulder[2] Dropoff (mm)	Lane-to-Shoulder Separation (mm)	Well Sealed (Y/N)
1.	0.0	__ __ __	__ __ __	__
2.	15.25	__ __ __	__ __ __	__
3.	30.5	__ __ __	__ __ __	__
4.	45.75	__ __ __	__ __ __	__
5.	61.0	__ __ __	__ __ __	__
6.	76.25	__ __ __	__ __ __	__
7.	91.5	__ __ __	__ __ __	__
8.	106.75	__ __ __	__ __ __	__
9.	122.0	__ __ __	__ __ __	__
10.	137.25	__ __ __	__ __ __	__
11.	152.5	__ __ __	__ __ __	__

Note 1. Point Distance is from the start of the test section to the measurement location. The values shown are S1 equivalents of the 50 ft spacing used in previous surveys.

Note 2. If heave of the shoulder occurs (upward movement), record as a negative (-) value. Do not record (+) sign, positive values are assumed.

B

MANUAL FOR FAULTMETER MEASUREMENTS

TABLE OF CONTENTS

INTRODUCTION

Measurement of Faulting in the LTPP Program

This manual is intended for use by the FHWA-LTPP Regional Coordination Office personnel and others responsible for using the faultmeter to measure JCP faulting, and for measuring lane-to-shoulder dropoff on LTPP pavement test sites.

The change in joint faulting and lane-to-shoulder dropoff with time are important indicators of pavement performance. The digital faultmeters will be used to collect this data. It is the responsibility of each regional coordination office contractor to store, maintain, and operate their faultmeter for faulting and lane-to-shoulder dropoff data collection.

The Georgia Digital Faultmeter

The electronic digital faultmeter was designed to simplify measuring concrete joint faulting. This meter was designed, developed and built by the Georgia Department of Transportation Office of Materials and Research personnel[1]. The faultmeter is very light and easy to use. The unit, shown in figure 1, weighs approximately 3.2 kg and supplies a digital readout with the push of a button located on the carrying handle. It reads out directly in millimeters (e.g., a digital readout of "6" indicates 6 mm of faulting) and shows whether the reading is positive or negative. The unit reads out in 1 second and freezes the reading in display so that it can be removed from the road before reading for safer operation. The legs of the faultmeter's base are set on the slab in the direction of traffic on the "leave side" of the joint. The measuring probe contacts the slab on the approach. Movement of this probe is transmitted to a Linear Variance Displacement Transducer to measure joint faulting. The joint must be centered between the guidelines shown on the side of the meter.

Any slab that is lower on the leave side of the joint will register as a positive faulting number. If the slab leaving the joint is higher, the meter gives a negative reading.

The amount of time it takes to complete the faulting survey of a LTPP test section depends on the number of joints and cracks encountered, and on the amount of time needed to measure and record the location of each joint and crack. Generally, it should take less than 30 minutes to measure and record faulting and lane-to-shoulder dropoff on a 150-m test section using this device.

The Mechanical Faultmeter

The mechanical faultmeter was designed as a backup to the Georgia Faultmeter. It is not intended for use as a primary measuring device for faulting. The mechanical faultmeter has the same "footprint" as the Georgia Faultmeter and should be used in a similar manner. It has a dial indicator instead of the Georgia Faultmeter's electronic digital readout. **The mechanical faultmeter also does not take negative faulting readings, and must be reversed to read negative faulting.**

OPERATING THE FAULTMETER

This section gives step-by-step operating instructions. The Georgia Faultmeter has several unique features, which have been added to simplify operations, increase range of measurement to 22 mm, and increase reach to 100 mm to allow for spanning spalls and excess joint material on the slab surface.

Use the right hand when testing the outside lane. This allows the operator to stand safely on the shoulder, facing traffic, while making the test. There is an arrow on the meter showing traffic direction. Set the meter on the leave side of the joint. A probe contacts the slab on the approach side. The joint must be centered approximately between the two marks on each side of the meter.

As indicated in Chapter 3 of the *Data Collection Guide*[2], faulting of transverse joints and cracks is measured as the difference in elevation to the nearest 1 mm between the pavement surface on either side of a transverse joint or crack. In cases of a widened lane, measure 0.3 m from the edge of the slab and 0.75 m from the outside edge of the lane edge stripe. When anomalies such as patching, spalling, and corner breaks are encountered, the faultmeter should be offset to avoid including such anomalies in the readings. The maximum offset is 0.3 m. A null value ("N") should be recorded and entered into the database when the surveyor is unable to take a measurement due to an anomaly.

FIGURE B1
The Georgia Faultmeter in Use

Three measurements are made at each location. The representative value of the readings is recorded to the nearest millimeter. Measurements are taken at every joint and crack. This data is to be recorded on distress survey sheet 6. The distance from the start of the test section to the point where the measurement is taken is also recorded. This distance is obtained with a metric tape measure. Faulting is assumed to be positive. Therefore, the space to the left of the entry of measured faulting is to be filled with a negative sign when necessary. If the approach slab is higher than the departure slab, no positive sign is to be entered. If the approach slab is lower, a negative sign is entered. The readings recorded on the faultmeter are reported in millimeters on sheet 6. Faulting measurements and sheet 6 are to be completed at the beginning of the distress survey. Point distance measurements entered on sheet 6 for joints and transverse cracks should be consistent between surveys of the same test section to an accuracy of less than 0.5 m. Evaluate point distance differences for previous measurements of ≥ 0.5 m with a metric tape measure. NOTE: The precise start point of surveys must be identified clearly in the field.

Lane-to-shoulder dropoff is measured as the difference in elevation to the nearest 1 mm between the pavement surface and the adjacent shoulder surface. Measurements are taken at the beginning of the test section and at 15.25 m intervals (a total of 11 measurements) at the lane/shoulder interface or joint. Lane-to-shoulder dropoff typically occurs when the outside shoulder settles. However, heave of the shoulder may occur due to frost action or swelling soil. If heave of the shoulder is present, record it as a negative value. At each point where there is no lane-to-shoulder dropoff, enter "0." This data should be entered again on JCP data sheet 7 and CRCP data sheet 10.

The distance from the center of the measuring probe to the edge of the base's forward foot is 100 mm to allow easy placement on the joint, and for more overhang, to measure shoulder dropoff. In addition, the base feet are 50 mm long, to bridge any bad crack or low spot in the pavement. The faultmeters will read up to 22 mm. Differential elevations greater than 22 mm will still need to be measured using the machined spacer block supplied with the faultmeter.

The operational procedures for the mechanical faultmeter are the same as for the Georgia Faultmeter, with the exception of taking negative faulting readings. The mechanical faultmeter must be reversed to record negative readings and lane-to-shoulder dropoff.

CALIBRATION

Surveyors must ensure that they have a working faultmeter with fully charged batteries prior to beginning a survey on a test section. Although the meter is very stable, it should be checked at the beginning and end of every use to assure correct readings. Calibration is checked by setting the meter on the calibration stand, which has been provided with the faultmeter. Align the front end of the faultmeter with the measuring probe on the 9-mm calibration block. In this position, a reading of 9 mm should be obtained. Then align the meter should with the measuring probe off the 9-mm calibration block. In this position, reading of 0 mm should be obtained.

As long as the "0" and "9" readings are obtained, the unit is working properly. If not, align the meter with the measuring probe off the 9-mm calibration block. In this position, if a reading of 0 mm is not obtained, reset the "0" with the "0" button and check the calibration again. Be sure to check for any electronic malfunction before checking the calibration. Weak batteries can also cause an erroneous reading.

Faultmeters that do not pass the calibration checks, or cannot be "zeroed" or have other maintenance problems, should be returned to FHWA's LTPP team distress coordinator for repair.

The calibration checks are the same for the mechanical faultmeter. "Zero" adjustments can be made to the mechanical faultmeter with a one-eighth-inch allen wrench by adjusting the dial indicator height with the set screw adjacent to the dial indicator. Care must be taken during adjustment to ensure that the measuring rod moves freely.

MAINTENANCE

The only maintenance normally required for the faultmeter is the routine recharging of the batteries. When the batteries no longer hold a charge, they should be replaced. The meter should be sent to FHWA's LTPP team for repairs, maintenance, and battery replacement.

The mechanical faultmeter requires no special maintenance.

If the measuring rod does not move freely, the readings will be in error. This should not be a problem, as the rod is made of stainless steel and will not rust. If the rod becomes coated with road film and dust, clean it with a damp cloth. Do not clean with penetrating oil or any products that will leave an oily residue, as this will cause dust to adhere to the rod. If the rod "clicks" when the meter is lifted from the pavement, this is a good indication that it is sliding freely.

REFERENCES

1. J. Stone, "Georgia Digital Faultmeter," Report FHWA-GA-91-SP9010, Federal Highway Administration, January 1991.

2. *Data Collection Guide for Long-Term Pavement Performance Studies,* Operation Guide SHRP-LTPP-OG-001, Strategic Highway Research Program, January 1990.