Identification of Distress Conditions in Traffic Pavements

Course No: C08-007

Credit: 8 PDH

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DISTRESS IDENTIFICATION MANUAL

for the

Long-Term Pavement Performance Program

U.S. Department of Transportation
Federal Highway Administration

PUBLICATION NO.
FHWA-RD-03-031
JUNE 2003

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.

T. Paul Teng, P.E.
Director
Office of Infrastructure
Research and Development

Notice

Technical Report Documentation Page

1. Report No. FHWA-RD-03-031	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Distress Identification Manual for the Long-Term Pavement Performance Program (Fourth Revised Edition)		5. Report Date June 2003
		6. Performing Organization Code
7. Author(s) John S. Miller and William Y. Bellinger		8. Performing Organization Report No.
9. Performing Organization Name and Address Office of Infrastructure Research and Development Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Office of Infrastructure Research and Development Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296		13. Type of Report and Period Covered Manual
		14. Sponsoring Agency Code
15. Supplementary Notes Technical Consultant: Aramis Lopez, HRDI-13		

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.

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No of Pages 164	22. Price

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

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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Appendix C

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.

1

DISTRESSES FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

This section covers asphalt concrete-surfaced pavements (ACP), including ACP overlays on either asphalt concrete (AC) or portland cement concrete (PCC) pavements. Each of the distresses has been grouped into one of the following categories:

- **A.** Cracking
- **B.** Patching and Potholes
- **C.** Surface Deformation
- **D.** Surface Defects
- **E.** Miscellaneous Distresses

Table 1 summarizes the various types of distress and unit of measurement. Some distresses also have defined severity levels.

TABLE 1. Asphalt Concrete-Surfaced Pavement Distress Types

DISTRESS TYPE	UNIT OF MEASURE	DEFINED SEVERITY LEVELS?
A. Cracking / page **3**		
1. Fatigue Cracking	Square Meters	Yes
2. Block Cracking	Square Meters	Yes
3. Edge Cracking	Meters	Yes
4a. Wheel Path Longitudinal Cracking	Meters	Yes
4b. Non-Wheel Path Longitudinal Cracking	Meters	Yes
5. Reflection Cracking at Joints		
Transverse Reflection Cracking	Not Measured	N/A
Longitudinal Reflection Cracking	Not Measured	N/A
6. Transverse Cracking	Number, Meters	Yes
B. Patching and Potholes / page **15**		
7. Patch/Patch Deterioration	Number, Square Meters	Yes
8. Potholes	Number, Square Meters	Yes
C. Surface Deformation / page **21**		
9. Rutting	Millimeters	No
10. Shoving	Number, Square Meters	No
D. Surface Defects / page **25**		
11. Bleeding	Square Meters	No
12. Polished Aggregate	Square Meters	No
13. Raveling	Square Meters	No
E. Miscellaneous Distresses / page **29**		
14. Lane-to-Shoulder Dropoff	Not Measured	N/A
15. Water Bleeding and Pumping	Number, Meters	No

This section includes the following distresses:

1. Fatigue Cracking
2. Block Cracking
3. Edge Cracking
4a. Longitudinal Cracking—Wheel Path
4b. Longitudinal Cracking—Non-Wheel Path
5. Reflection Cracking at Joints
6. Transverse Cracking

Measurement of crack width is illustrated in Figure 1. Figure 2 depicts the effect on severity level of a crack, in this case block cracking, due to associated random cracking.

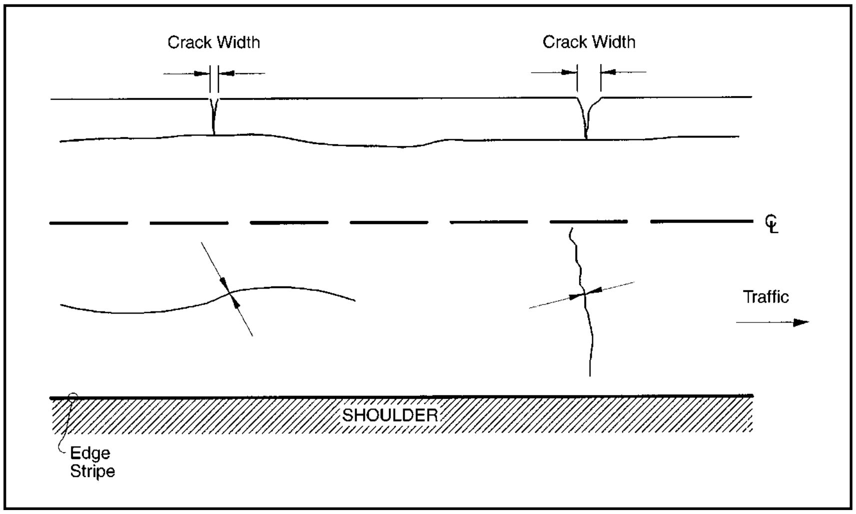


FIGURE 1
Measuring Crack Width in Asphalt Concrete-Surfaced Pavements

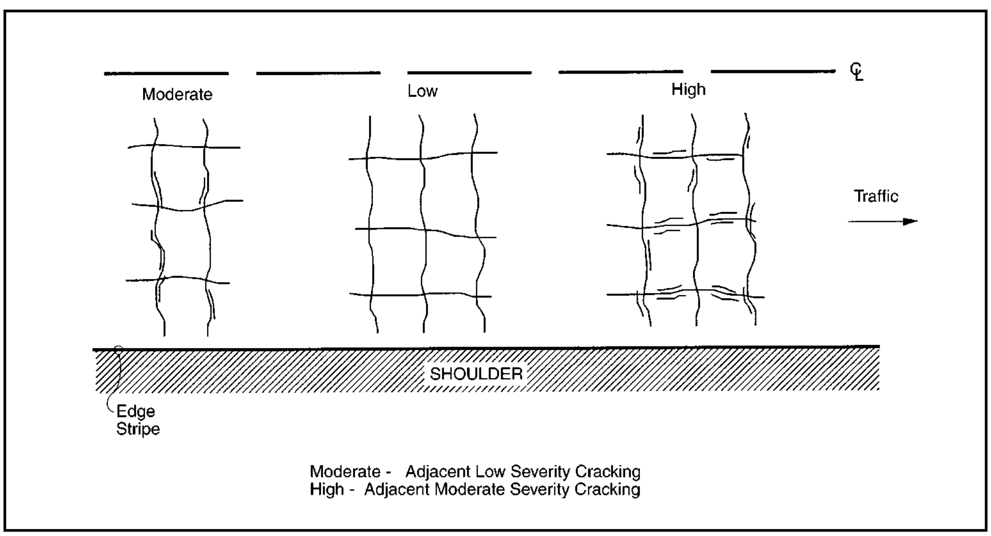


FIGURE 2
Effect on Severity Level of Block Cracking due to Associated Random Cracking

1

FATIGUE CRACKING

Description

Occurs in areas subjected to repeated traffic loadings (wheel paths). Can be a series of interconnected cracks in early stages of development. Develops into many-sided, sharp-angled pieces, usually less than 0.3 meters (m) on the longest side, characteristically with a chicken wire/alligator pattern, in later stages.

Must have a quantifiable area.

Severity Levels

LOW
An area of cracks with no or only a few connecting cracks; cracks are not spalled or sealed; pumping is not evident.

MODERATE
An area of interconnected cracks forming a complete pattern; cracks may be slightly spalled; cracks may be sealed; pumping is not evident.

HIGH
An area of moderately or severely spalled interconnected cracks forming a complete pattern; pieces may move when subjected to traffic; cracks may be sealed; pumping may be evident.

How to Measure

Record square meters of affected area at each severity level. If different severity levels existing within an area cannot be distinguished, rate the entire area at the highest severity present.

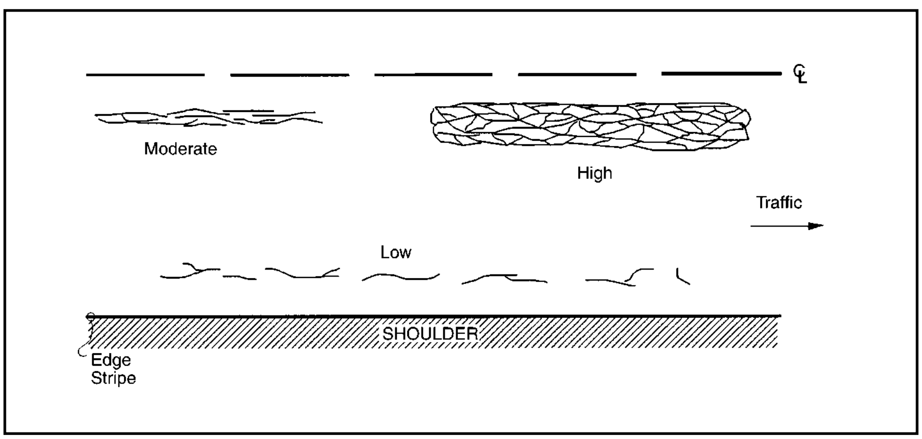


FIGURE 3
Distress Type ACP 1—Fatigue Cracking

FIGURE 4
Distress Type ACP 1—Chicken Wire/Alligator Pattern Cracking Typical in Fatigue Cracking

FIGURE 5
Distress Type ACP 1—Low Severity Fatigue Cracking

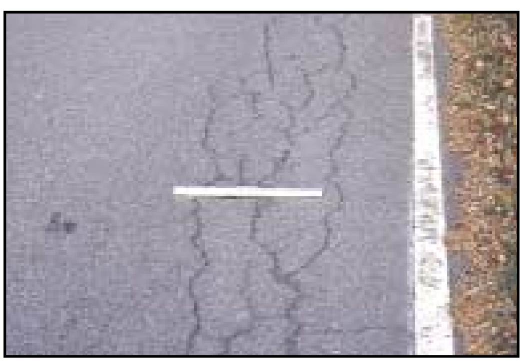


FIGURE 6
Distress Type ACP 1—Moderate Severity Fatigue Cracking

FIGURE 7
Distress Type ACP 1—High Severity Fatigue Cracking with Spalled Interconnected Cracks

2

BLOCK CRACKING

Description

A pattern of cracks that divides the pavement into approximately rectangular pieces. Rectangular blocks range in size from approximately 0.1 m² to 10 m².

Severity Levels

LOW
Cracks with a mean width ≤ 6 millimeters (mm); or sealed cracks with sealant material in good condition and with a width that cannot be determined.

MODERATE
Cracks with a mean width > 6 mm and ≤ 19 mm; or any crack with a mean width ≤ 19 mm and adjacent low severity random cracking.

HIGH
Cracks with a mean width > 19 mm; or any crack with a mean width ≤ 19 mm and adjacent moderate to high severity random cracking.

How to Measure

Record square meters of affected area at each severity level. If fatigue cracking exists within the block cracking area, the area of block cracking is reduced by the area of fatigue cracking.

Note: An occurrence should be at least 15 m long before rating as block cracking.

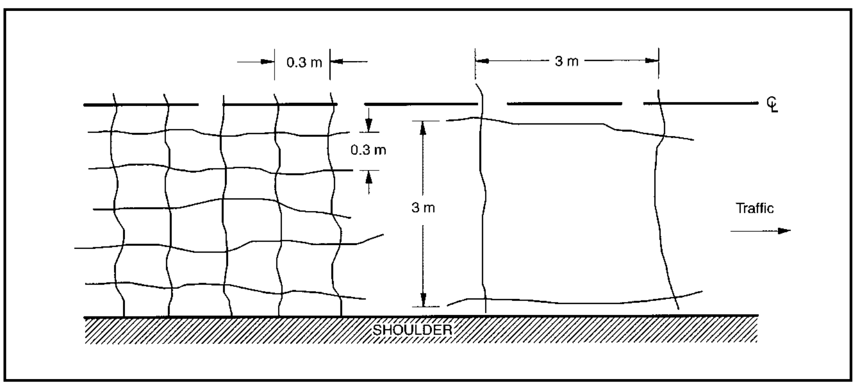


FIGURE 8
Distress Type ACP 2—Block Cracking

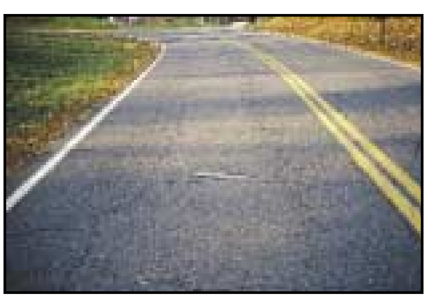


FIGURE 9
Distress Type ACP 2—Block Cracking with Fatigue Cracking in the Wheel Paths

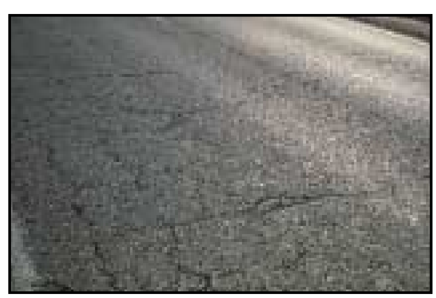


FIGURE 10
Distress Type ACP 2—High Severity Block Cracking

EDGE CRACKING

Description

Applies only to pavements with unpaved shoulders. Crescent-shaped cracks or fairly continuous cracks which intersect the pavement edge and are located within 0.6 m of the pavement edge, adjacent to the shoulder. Includes longitudinal cracks outside of the wheel path and within 0.6 m of the pavement edge.

Severity Levels

LOW
Cracks with no breakup or loss of material.

MODERATE
Cracks with some breakup and loss of material for up to 10 percent of the length of the affected portion of the pavement.

HIGH
Cracks with considerable breakup and loss of material for more than 10 percent of the length of the affected portion of the pavement.

How to Measure

Record length in meters of pavement edge affected at each severity level. The combined quantity of edge cracking cannot exceed the length of the section.

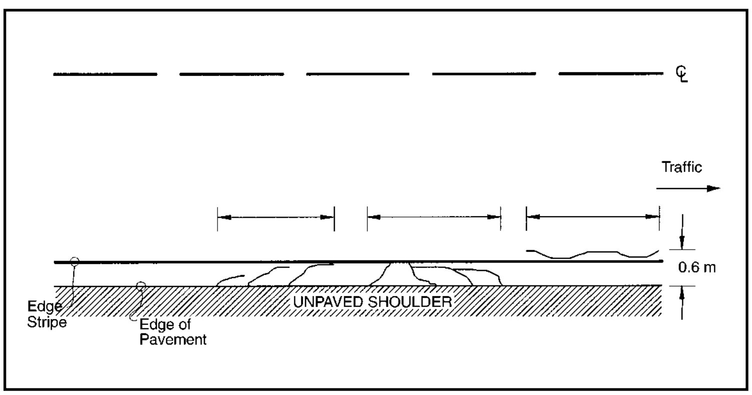


FIGURE 11
Distress Type ACP 3—Edge Cracking

FIGURE 12
Distress Type ACP 3—Low Severity Edge Cracking

LONGITUDINAL CRACKING

Description

Cracks predominantly parallel to pavement centerline. Location within the lane (wheel path versus non-wheel path) is significant.

Severity levels

LOW
A crack with a mean width ≤ 6 mm; or a sealed crack with sealant material in good condition and with a width that cannot be determined.

MODERATE
Any crack with a mean width > 6 mm and ≤ 19 mm; or any crack with a mean width ≤ 19 mm and adjacent low severity random cracking.

HIGH
Any crack with a mean width > 19 mm; or any crack with a mean width ≤ 19 mm and adjacent moderate to high severity random cracking.

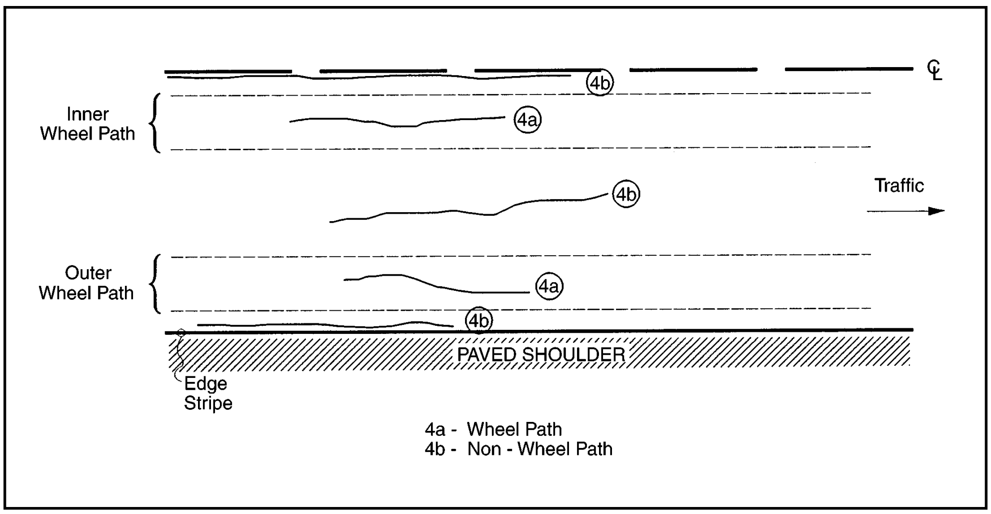


FIGURE 13
Distress Type ACP 4—Longitudinal Cracking

How to Measure

Record separately:

4A. WHEEL PATH LONGITUDINAL CRACKING
Record the length in meters of longitudinal cracking within the defined wheel paths at each severity level.

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

Note: Any wheel path longitudinal crack that has associated random cracking is rated as fatigue cracking. Any wheel path longitudinal crack that meanders and has a quantifiable area is rated as fatigue cracking.

4B. NON-WHEEL PATH LONGITUDINAL CRACKING
Record the length in meters of longitudinal cracking not located in the defined wheel paths at each severity level.

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

FIGURE 14
Distress Type ACP 4a—Moderate Severity Longitudinal Cracking in the Wheel Path

FIGURE 15
Distress Type ACP 4b—High Severity Longitudinal Cracking not in the Wheel Path

5

REFLECTION CRACKING AT JOINTS

Description

Cracks in asphalt concrete overlay surfaces that occur over joints in concrete pavements.

Note: The slab dimensions beneath the AC surface must be known to identify reflection cracks at joints.

Severity Levels

LOW
An unsealed crack with a mean width ≤ 6 mm; or a sealed crack with sealant material in good condition and with a width that cannot be determined.

MODERATE
Any crack with a mean width > 6 mm and ≤ 19 mm; or any crack with a mean width ≤ 19 mm and adjacent low severity random cracking.

HIGH
Any crack with a mean width > 19 mm; or any crack with a mean width ≤ 19 mm and adjacent moderate to high severity random cracking.

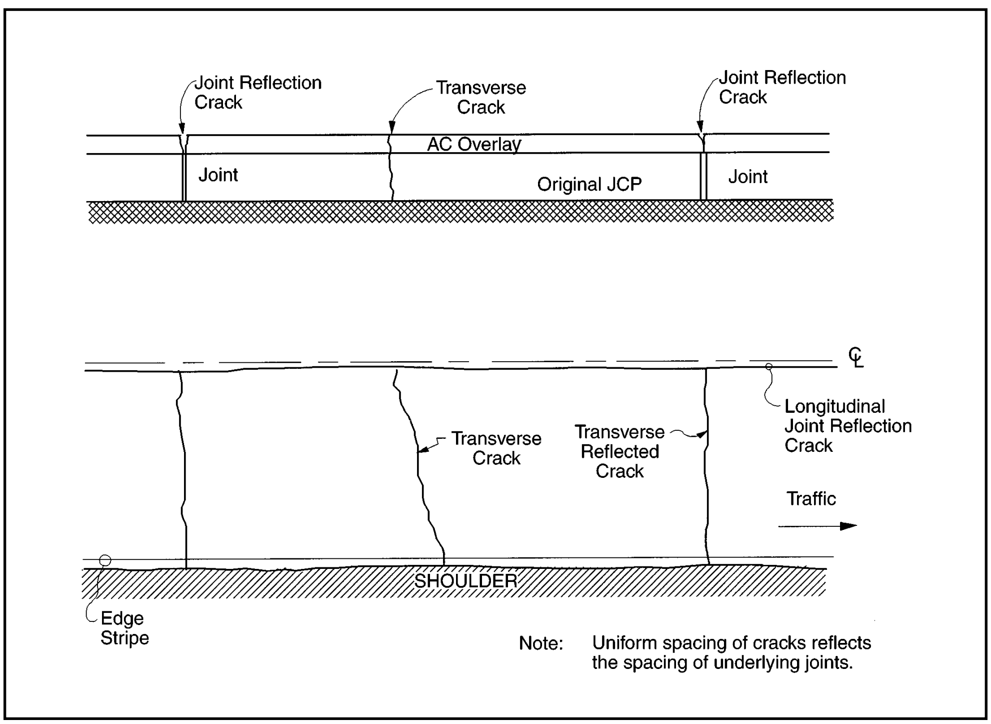


FIGURE 16
Distress Type ACP 5—Reflection Cracking at Joints

How to Measure

Recorded as longitudinal cracking (ACP4) or transverse cracking (ACP6) on LTPP surveys.

FIGURE 17
Distress Type ACP 5—High Severity Reflection Cracking at Joints

6

TRANSVERSE CRACKING

Description

Cracks that are predominantly perpendicular to pavement centerline.

Severity Levels

LOW
An unsealed crack with a mean width ≤ 6 mm; or a sealed crack with sealant material in good condition and with a width that cannot be determined.

MODERATE
Any crack with a mean width > 6 mm and ≤ 19 mm; or any crack with a mean width ≤ 19 mm and adjacent low severity random cracking.

HIGH
Any crack with a mean width > 19 mm; or any crack with a mean width ≤ 19 mm and adjacent moderate to high severity random cracking.

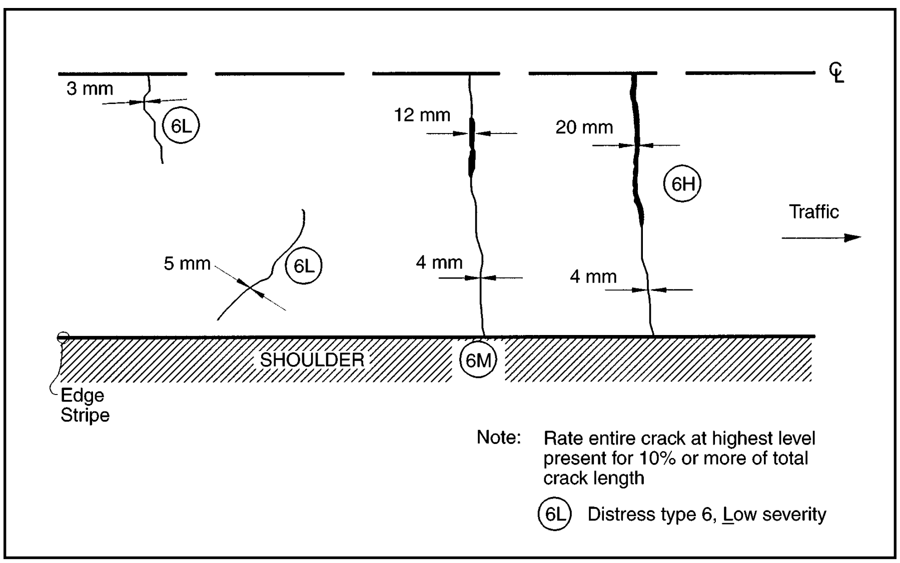


FIGURE 18
Distress Type ACP 6—Transverse Cracking Asphalt Concrete Surfaces

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 length in meters of transverse cracks with sealant in good condition at each severity level.

Note: The length recorded 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.

If the transverse crack extends through an area of fatigue cracking, the length of the crack within the fatigue area is not counted. The crack is treated as a single transverse crack, but at a reduced length.

Cracks less than 0.3 m in length are not recorded.

FIGURE 19
Distress Type ACP 6—Low Severity Transverse Cracking

FIGURE 20
Distress Type ACP 6—Moderate Severity Transverse Cracking

FIGURE 21
Distress Type ACP 6—High Severity Transverse Cracking

B

Patching and Potholes

This section includes the following distresses:

7. Patch/Patch Deterioration
8. Potholes

7

PATCH/PATCH DETERIORATION

Description

Portion of pavement surface, greater than 0.1 m^2, 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 including rutting < 6 mm; pumping is not evident.

MODERATE

Patch has moderate severity distress of any type or rutting from 6 mm to 12 mm; pumping is not evident.

HIGH

Patch has high severity distress of any type including rutting > 12 mm, or the patch has additional different patch material within it; pumping may be evident.

How to Measure

Record number of patches and square meters of affected surface area at each severity level.

Note: Any distress in the boundary of the patch is included in rating the patch. Rutting (settlement) may be at the perimeter or interior of the patch.

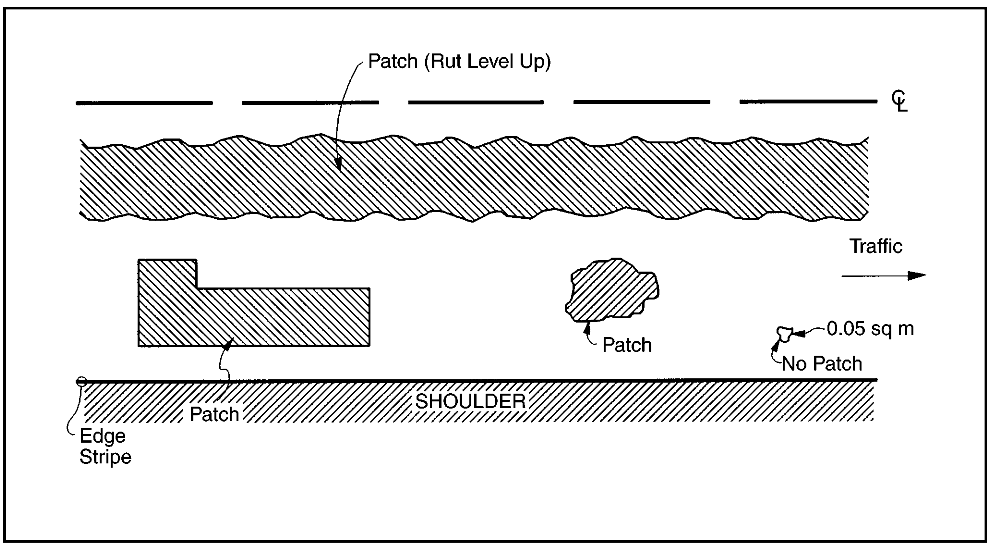


FIGURE 22
Distress Type ACP 7—Patch/Patch Deterioration

FIGURE 23
Distress Type ACP 7—Low Severity Patch

FIGURE 24
Distress Type ACP 7—Moderate Severity Patch

FIGURE 25
Distress Type ACP 7—High Severity Patch

8

POTHOLES

Description

Bowl-shaped holes of various sizes in the pavement surface. Minimum plan dimension is 150 mm.

Severity Levels

LOW
< 25 mm deep.

MODERATE
25 mm to 50 mm deep.

HIGH
> 50 mm deep.

How to Measure

Record number of potholes and square meters of affected area at each severity level. Pothole depth is the maximum depth below pavement surface. If pothole occurs within an area of fatigue cracking the area of fatigue cracking is reduced by the area of the pothole.

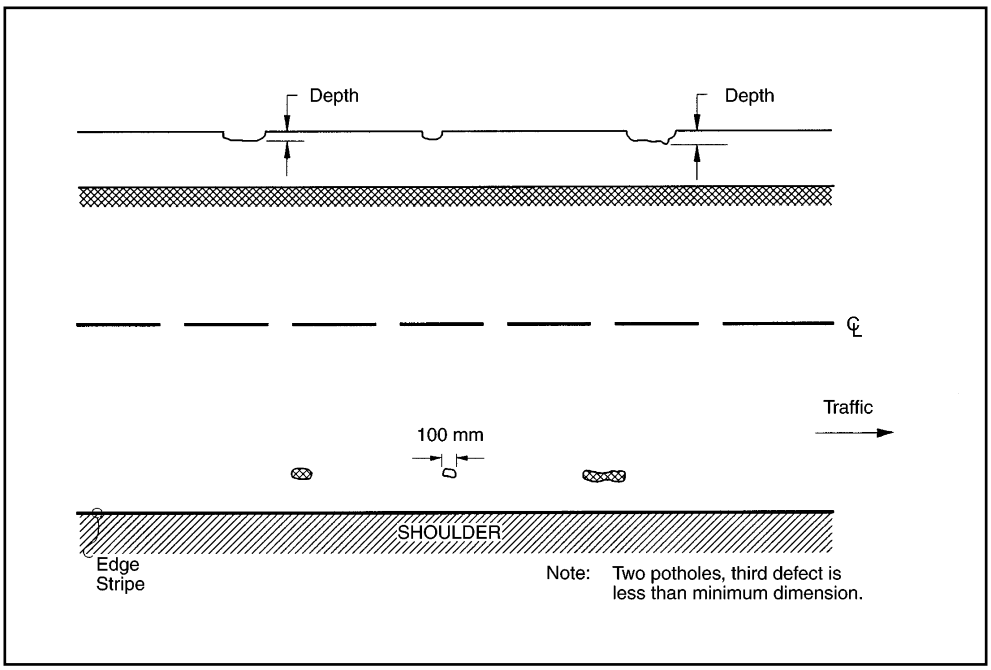


FIGURE 26
Distress Type ACP 8—Potholes

ASPHALT
CONCRETE
SURFACES

FIGURE 27
Distress Type ACP 8—Low Severity Pothole

FIGURE 28
Distress Type ACP 8—Moderate Severity Pothole

FIGURE 29
Distress Type ACP 8—Moderate Severity Pothole, Close-up View

FIGURE 30
Distress Type ACP 8—High Severity Pothole, Close-up View

C

Surface Deformation

This section includes the following types of surface deformations:

9. Rutting
10. Shoving

9

RUTTING

Description

A rut is a longitudinal surface depression in the wheel path. It may have associated transverse displacement.

Severity Levels

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

How to Measure

Specific Pavement Studies (SPS)-3 ONLY. Record maximum rut depth to the nearest millimeter, at 15.25-m intervals for each wheel path, as measured with a 1.2-m straight edge.

All other LTPP sections: Transverse profile is measured with a Dipstick® profiler at 15.25-m intervals.

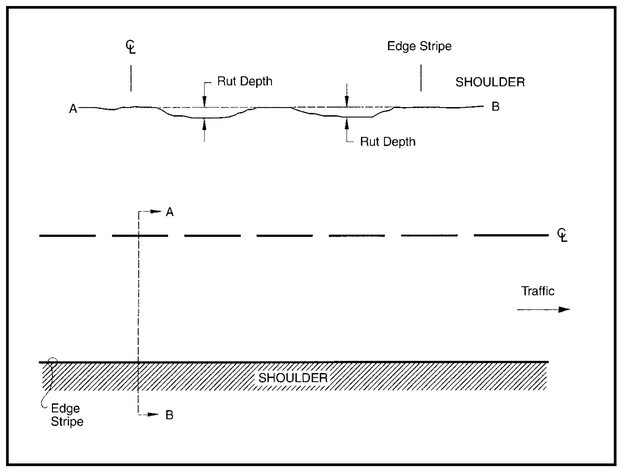


FIGURE 31
Distress Type ACP 9—Rutting

FIGURE 32
Distress Type ACP 9—Rutting

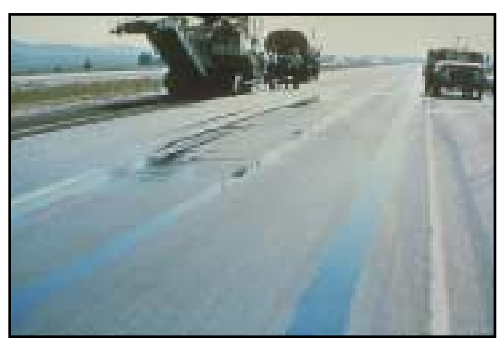


FIGURE 33
Distress Type ACP 9—Standing Water in Ruts

SHOVING

Description

Shoving is a longitudinal displacement of a localized area of the pavement surface. It is generally caused by braking or accelerating vehicles, and is usually located on hills or curves, or at intersections. It also may have associated vertical displacement.

Severity Levels

Not applicable. However, severity levels can be defined by the relative effect of shoving on ride quality.

How to Measure

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

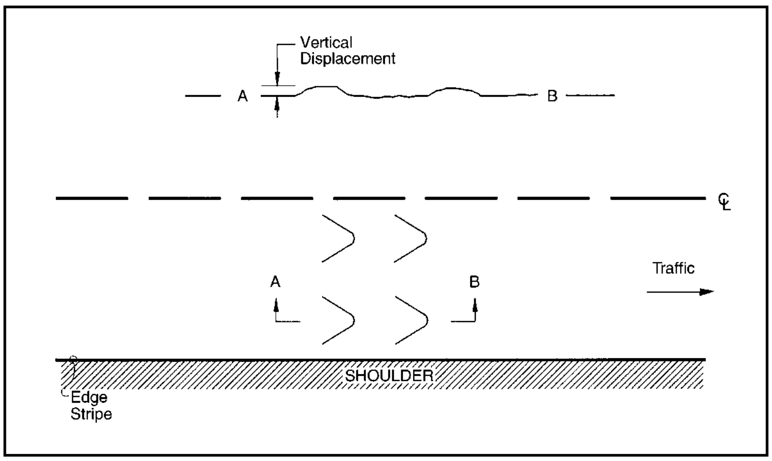


FIGURE 34
Distress Type ACP 10—Shoving

FIGURE 35
Distress Type ACP 10—Shoving in Pavement Surface

D

Surface Defects

This section includes the following types of surface defects:

11. Bleeding
12. Polished Aggregate
13. Raveling

11

BLEEDING

Description

Excess bituminous binder occurring on the pavement surface, usually found in the wheel paths. May range from a surface discolored relative to the remainder of the pavement, to a surface that is losing surface texture because of excess asphalt, to a condition where the aggregate may be obscured by excess asphalt possibly with a shiny, glass-like, reflective surface that may be tacky to the touch.

Severity Levels

Not applicable. The presence of bleeding indicates potential mixture related performance problems. Extent is sufficient to monitor any progression.

How to Measure

Record square meters of surface area affected.

Note: Preventative maintenance treatments (slurry seals, chip seals, fog seals, etc.) sometimes exhibit bleeding characteristics. These occurrences should be noted, but not rated as bleeding.

FIGURE 36
Distress Type ACP 11—Discoloration

FIGURE 37
Distress Type ACP 11—Loss of Texture

FIGURE 38
Distress Type ACP 11—Aggregate Obscured

POLISHED AGGREGATE

Description

Surface binder 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. Polished aggregate should not be rated on test sections that have received a preventive maintenance treatment that has covered the original pavement surface.

FIGURE 39
Distress Type ACP 12—Polished Aggregate

13

RAVELING

Description

Wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. Raveling ranges from loss of fines to loss of some coarse aggregate and ultimately to a very rough and pitted surface with obvious loss of aggregate.

Severity Levels

Not applicable. The presence of raveling indicates potential mixture related performance problems. Extent is sufficient to monitor any progression.

How to Measure

Record square meters of affected surface. Raveling should not be rated on chip seals.

FIGURE 40
Distress Type ACP 13—Loss of Fine Aggregate

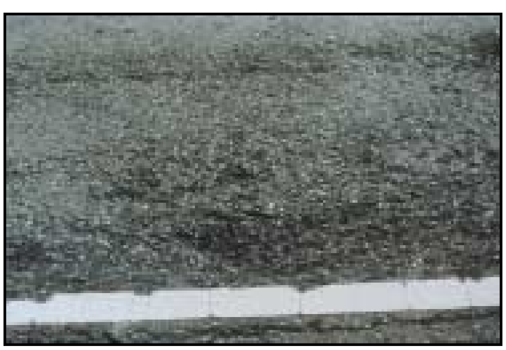


FIGURE 41
Distress Type ACP 13—Loss of Fine and Some Coarse Aggregate

FIGURE 42
Distress Type ACP 13—Loss of Coarse Aggregate

E

Miscellaneous Distresses

This section includes the following distresses:

14. Lane-to-Shoulder Dropoff
15. Water Bleeding and Pumping

14

LANE-TO-SHOULDER DROPOFF

Description

Difference in elevation between the traveled surface and the outside shoulder. Typically occurs when the outside shoulder settles as a result of pavement layer material differences.

Severity Level

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

How to Measure

Not recorded in LTPP surveys.

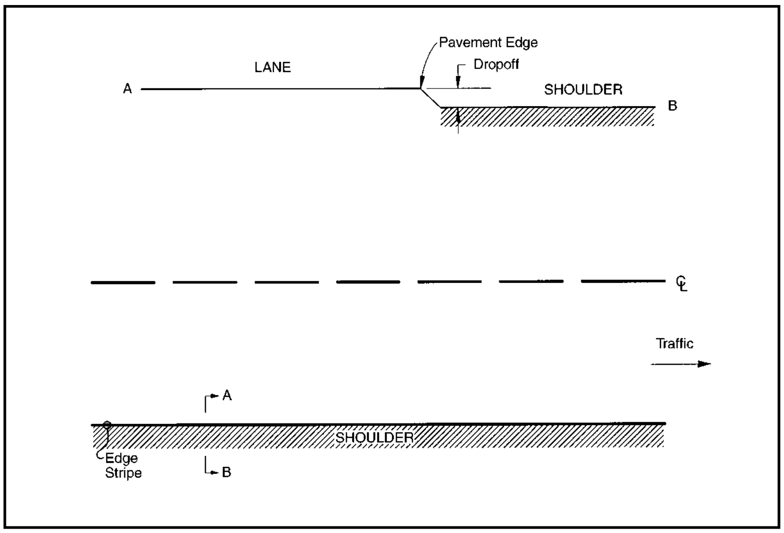


FIGURE 43
Distress Type ACP 14—Lane-to-Shoulder Dropoff

FIGURE 44
Distress Type ACP 14—Lane-to-Shoulder Dropoff

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 45
Distress Type ACP 15—Water Bleeding and Pumping

FIGURE 46
Distress Type ACP 15—Fine Material Left on Surface by Water Bleeding and Pumping

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

A

Cracking

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.

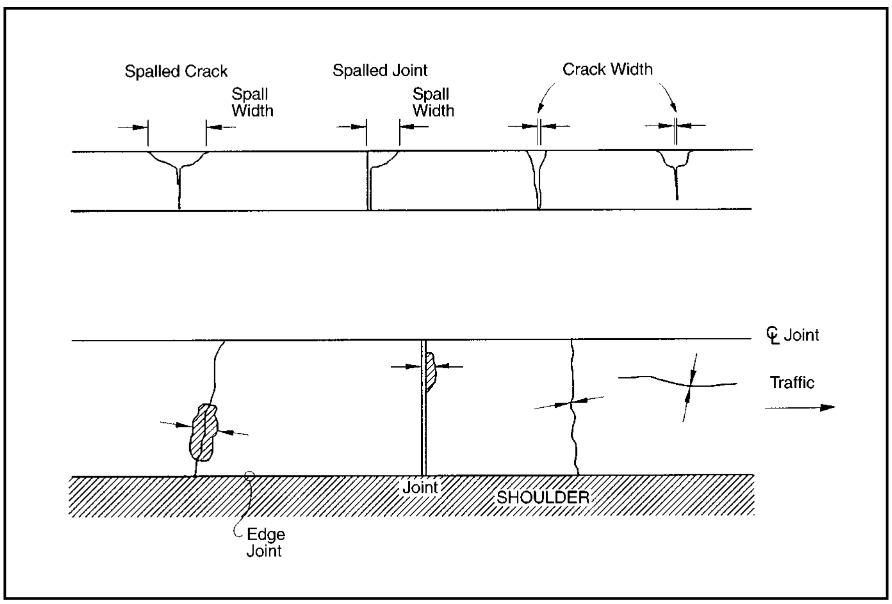


FIGURE 47
Measuring Widths of Spalls and Cracks in Jointed Concrete Pavement

1

CORNER BREAKS

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.

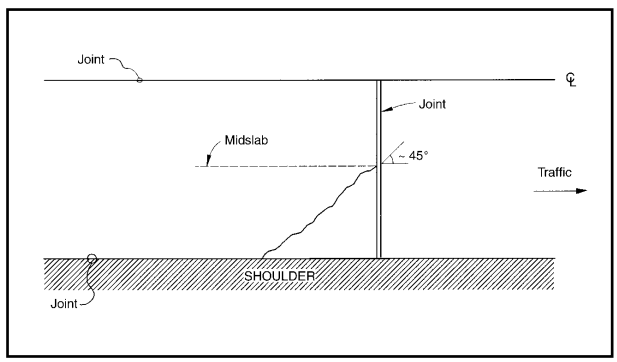


FIGURE 48
Distress Type JCP 1—Corner Breaks

FIGURE 49
Distress Type JCP 1—Low Severity Corner Break

FIGURE 50
Distress Type JCP 1—Moderate Severity Corner Break

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 m², may have been patched.

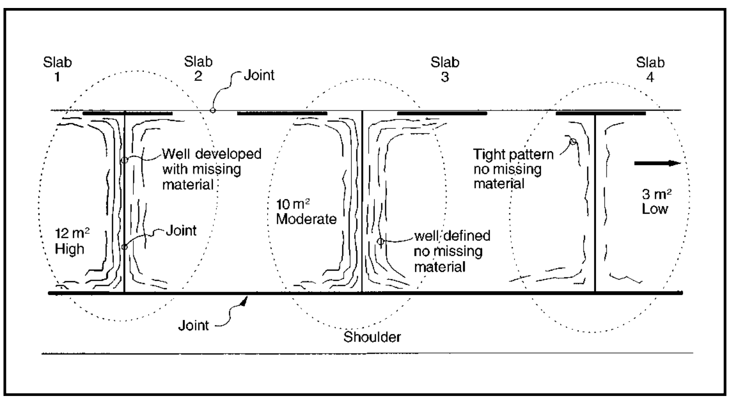


FIGURE 51
Distress Type JCP 2—Durability Cracking ("D" Cracking)

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

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

3

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.

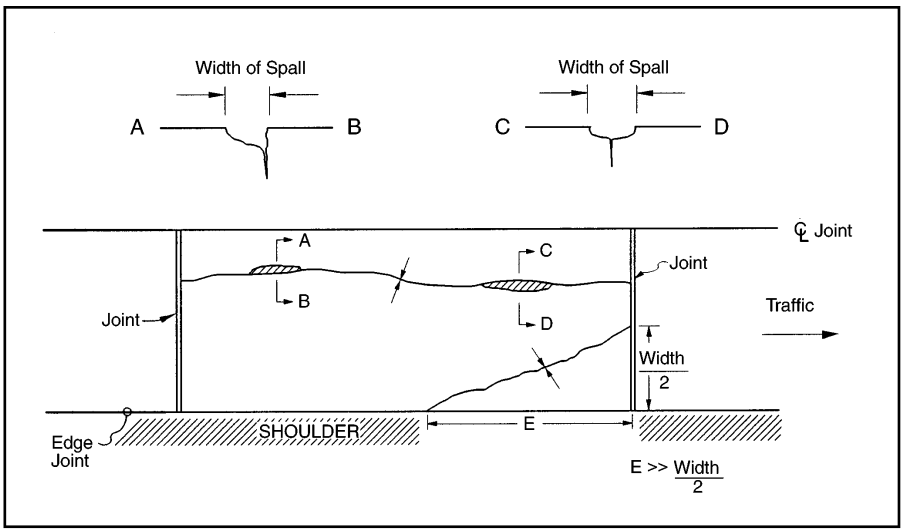


FIGURE 54
Distress Type JCP 3—Longitudinal Cracking

JOINTED PORTLAND CEMENT CONCRETE SURFACES

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.

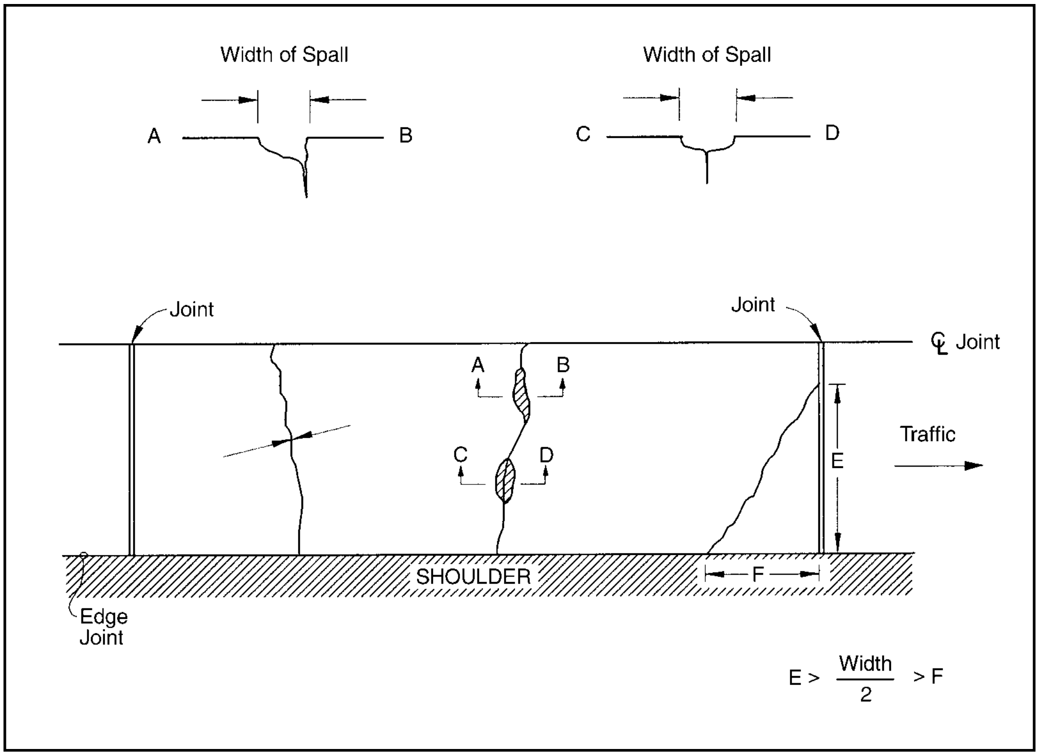


FIGURE 58
Distress Type JCP 4—Transverse Cracking

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.

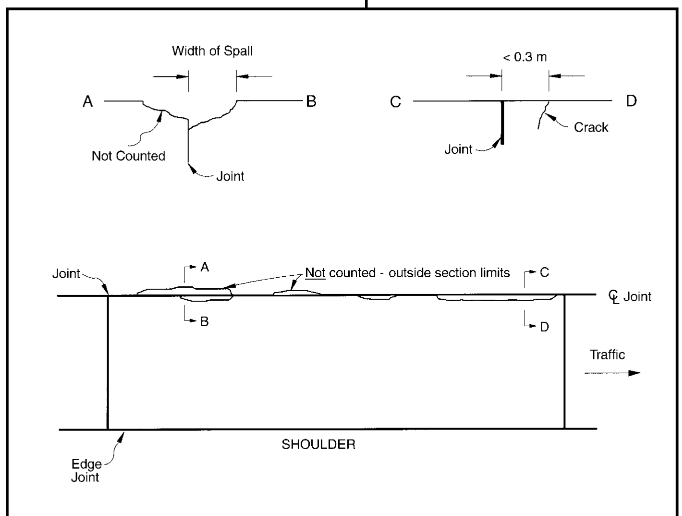


FIGURE 63
Distress Type JCP 6—Spalling of Longitudinal Joints

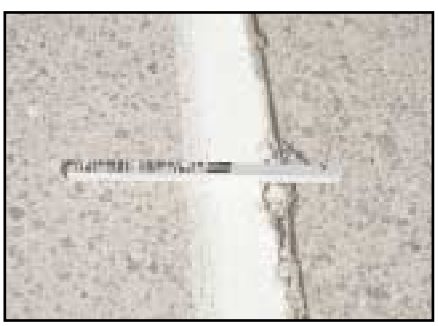


FIGURE 64
Distress Type JCP 6—Low Severity Spalling of Longitudinal Joint

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

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.

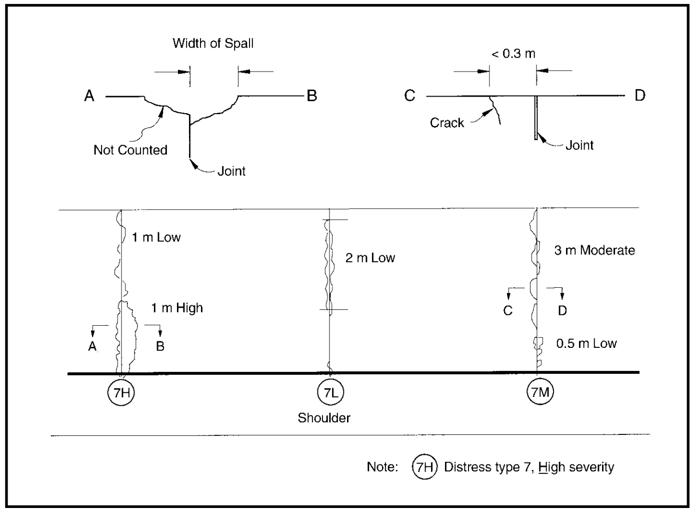


FIGURE 66
Distress Type JCP 7—Spalling of Transverse Joints

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

8

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.

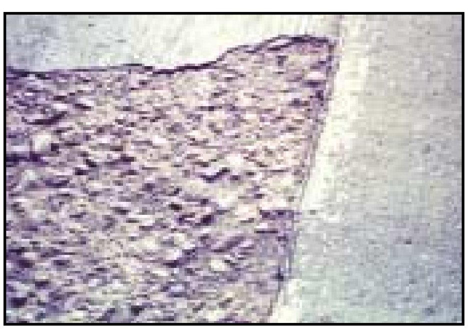


FIGURE 70
Distress Type JCP 8b—Scaling

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

10

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.

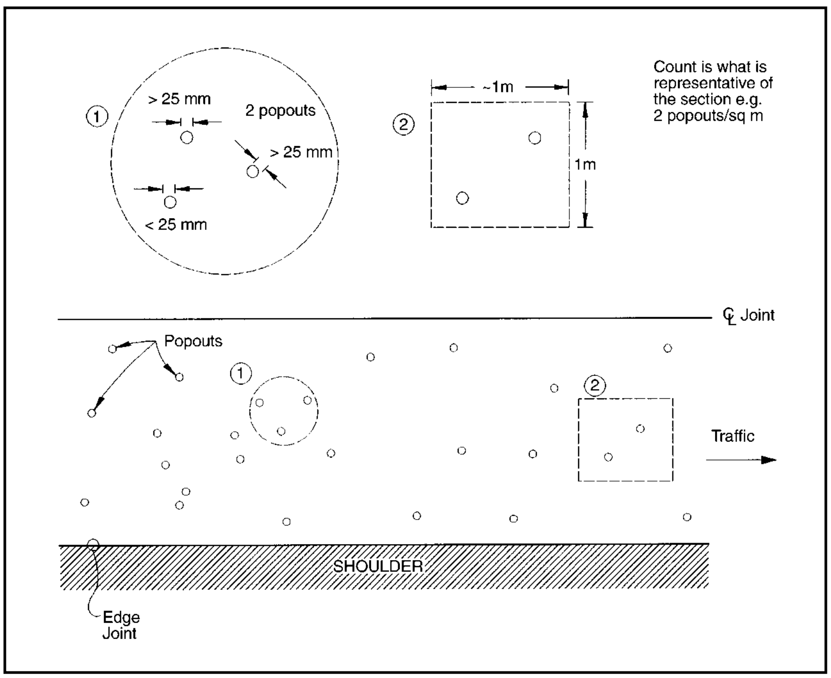


FIGURE 73
Distress Type JCP 10—Popouts

FIGURE 74
Distress Type JCP 10—A Popout

JOINTED PORTLAND CEMENT CONCRETE SURFACES

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.

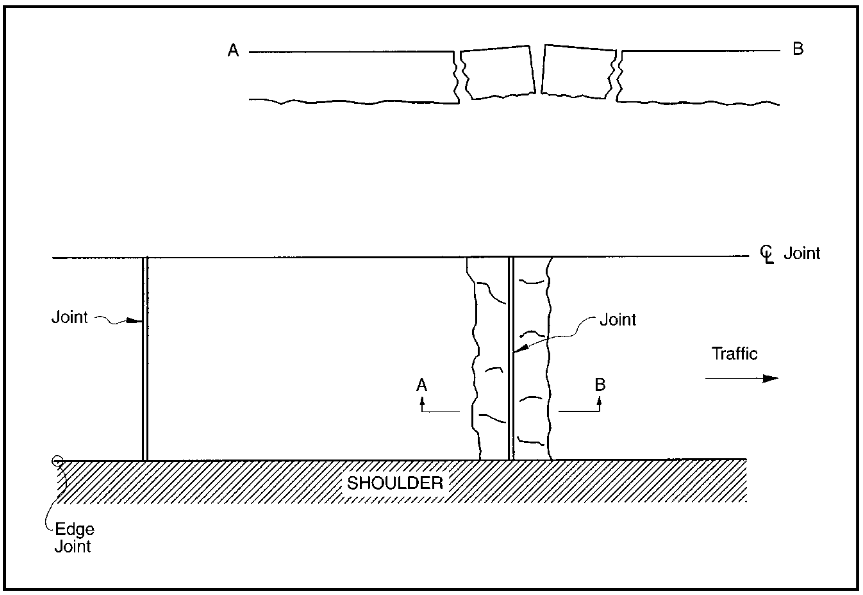


FIGURE 75
Distress Type JCP 11—Blowups

FIGURE 76
Distress Type JCP 11—A Blowup

JOINTED PORTLAND CEMENT CONCRETE SURFACES

FAULTING OF TRANSVERSE JOINTS AND CRACKS

12

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.

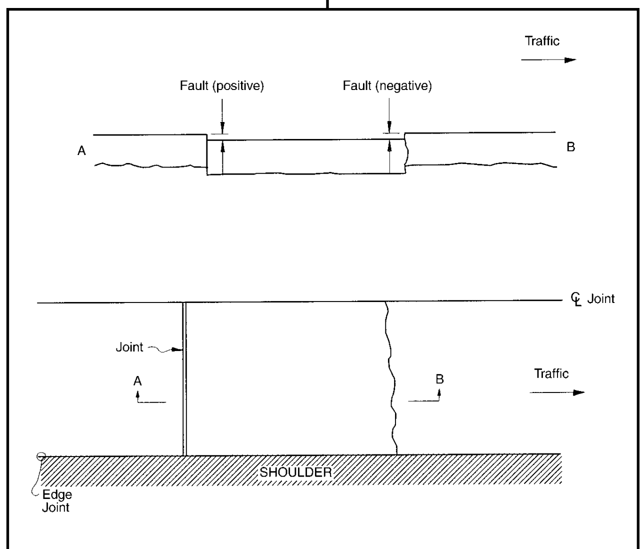


FIGURE 77
Distress Type JCP 12—Faulting of Transverse Joints and Cracks

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

13

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.

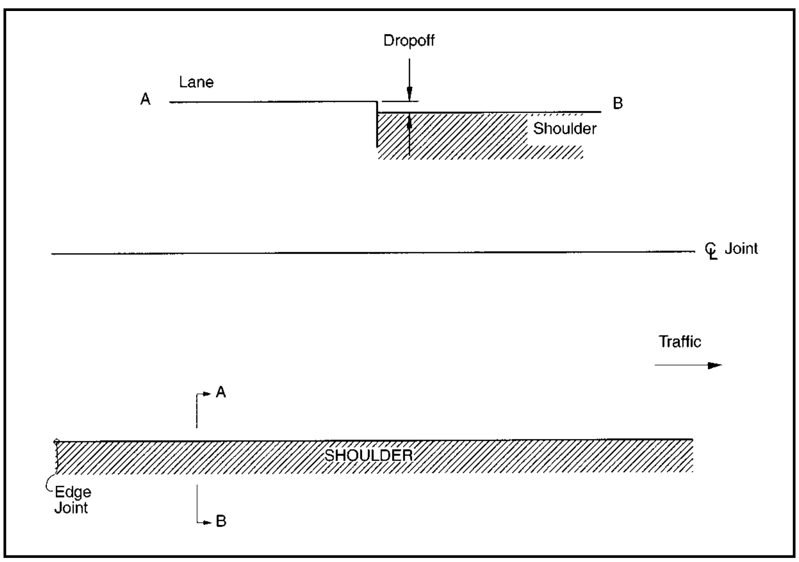


FIGURE 79
Distress Type JCP 13—
Lane-to-Shoulder Dropoff

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

JOINTED PORTLAND CEMENT 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 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.

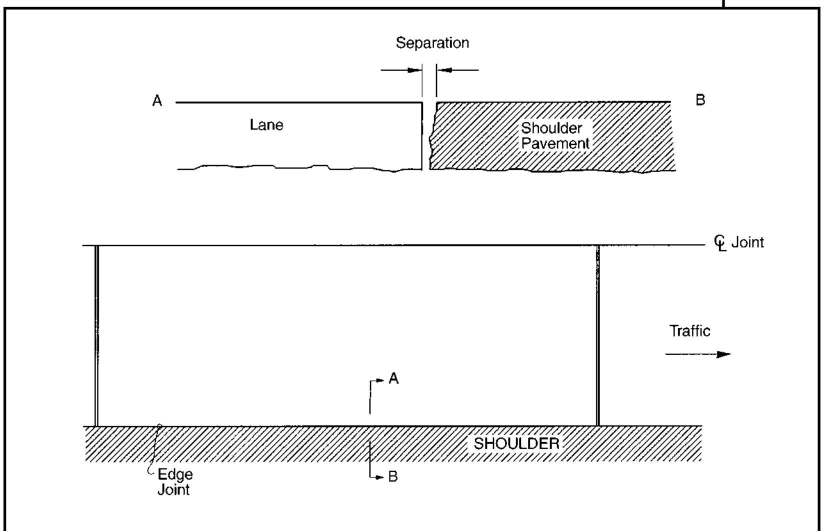


FIGURE 81
Distress Type JCP 14—Lane-to-Shoulder Separation

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.

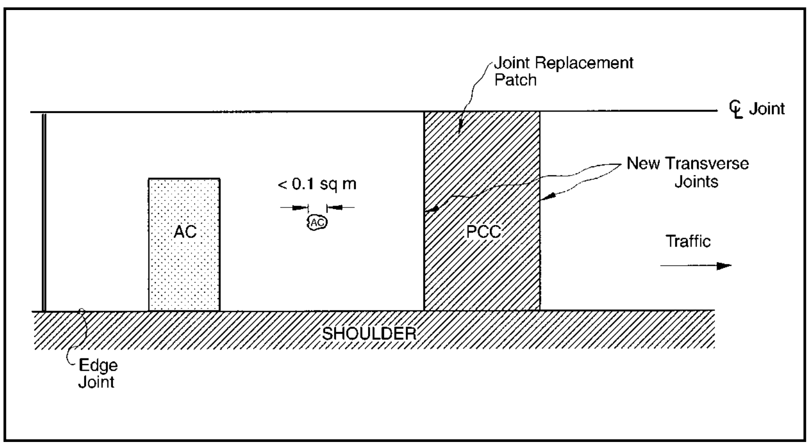


FIGURE 84
Distress Type JCP 15—Patch/Patch Deterioration

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

JOINTED PORTLAND CEMENT CONCRETE SURFACES

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

1

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 m^2, may have been patched.

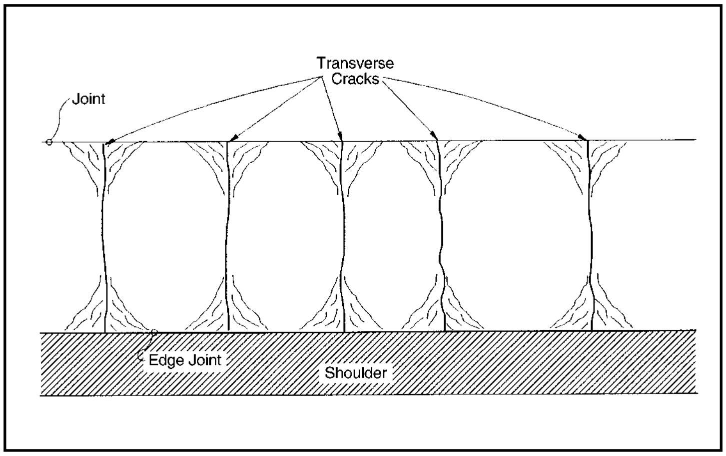


FIGURE 90
Distress Type CRCP 1—Durability Cracking ("D" Cracking)

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.

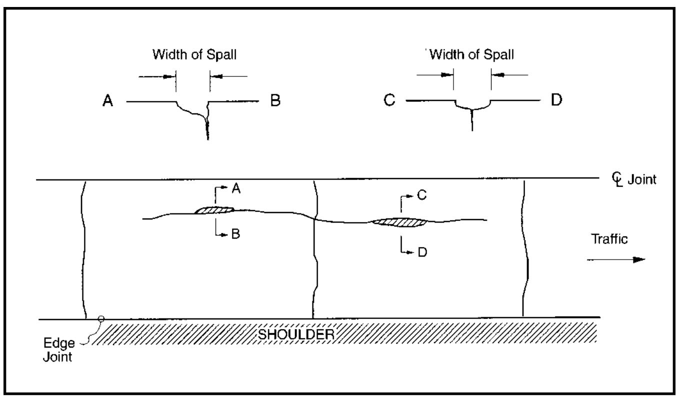


FIGURE 93
Distress Type CRCP 2—Longitudinal Cracking

Figure 94
Distress Type CRCP 2—Low Severity Longitudinal Cracking

FIGURE 95
Distress Type CRCP 2—High Severity Longitudinal Cracking

3

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.

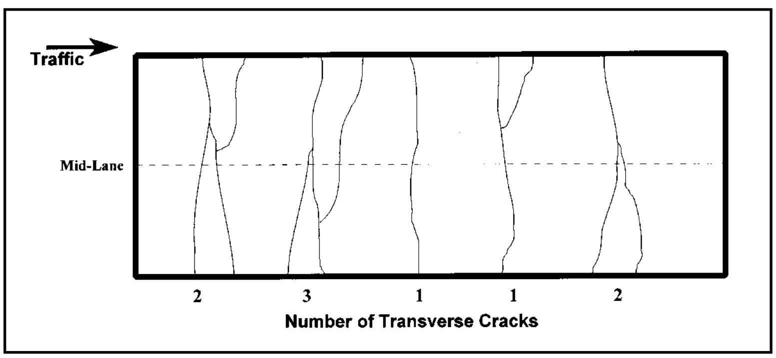


FIGURE 96
Distress Type CRCP 3—Transverse Cracking

FIGURE 97
Distress Type CRCP 3—Transverse Cracking Pattern

CONTINUOUSLY REINFORCED CONCRETE SURFACES

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

6

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.

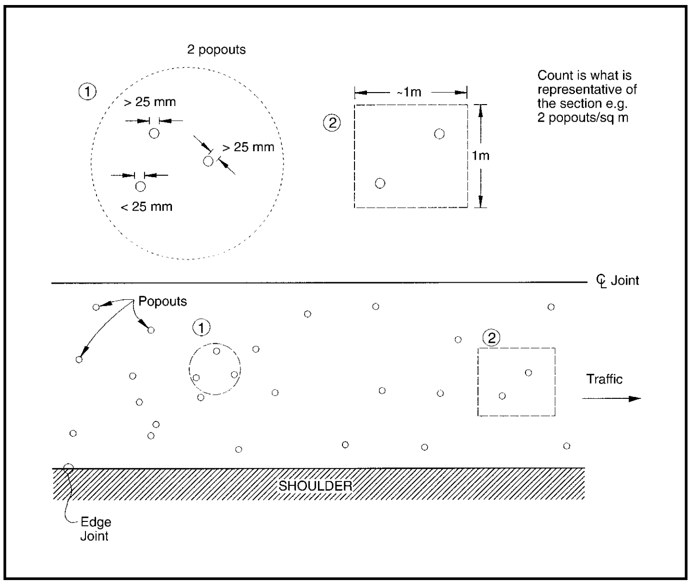


FIGURE 104
Distress Type CRCP 6—Popouts

FIGURE 105
Distress Type CRCP 6—Popouts

CONTINUOUSLY REINFORCED CONCRETE SURFACES

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.

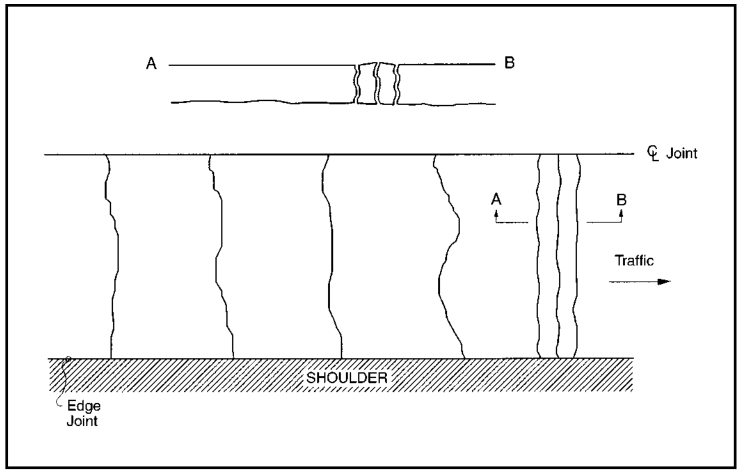


FIGURE 106
Distress Type CRCP 7—Blowups

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

TRANSVERSE CONSTRUCTION JOINT DETERIORATION

8

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.

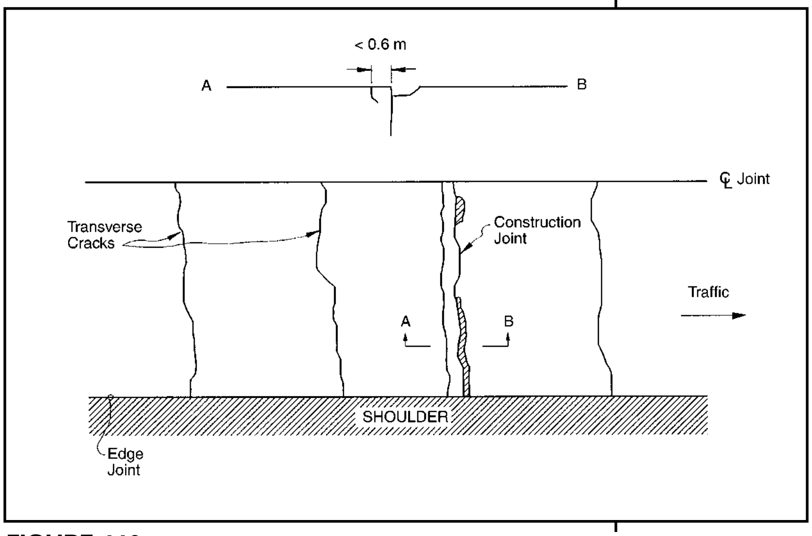


FIGURE 110
Distress Type CRCP 8—Transverse Construction Joint Deterioration

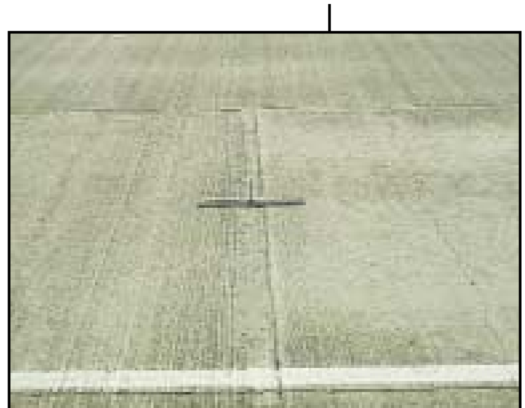


FIGURE 111
Distress Type CRCP 8—Low Severity Transverse Construction Joint Deterioration

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.

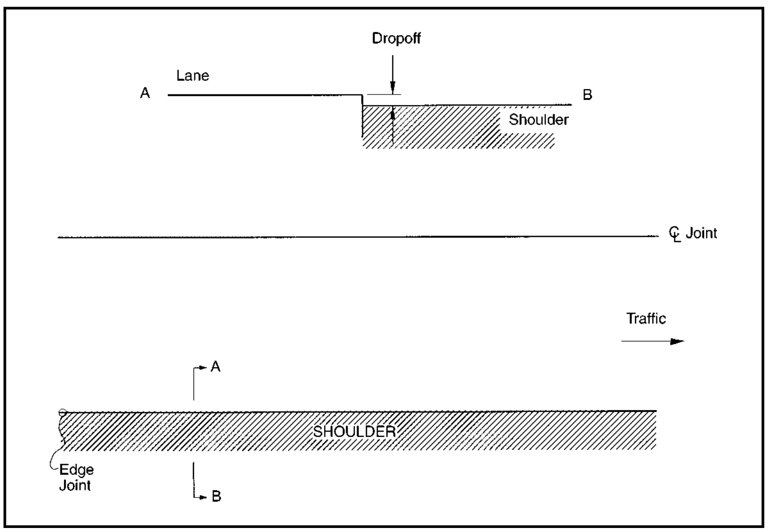


FIGURE 114
Distress Type CRCP 9—Lane-to-Shoulder Dropoff

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.

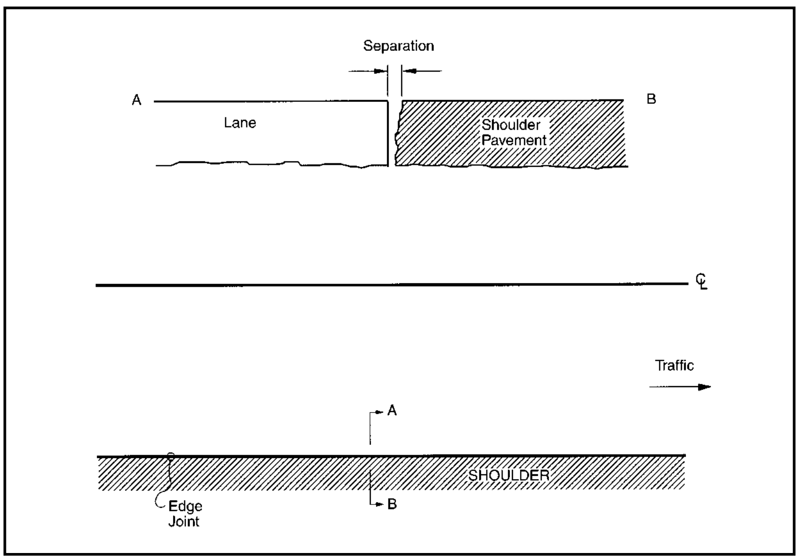


FIGURE 116
Distress Type CRCP 10—Lane-to-Shoulder Separation

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

11

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.

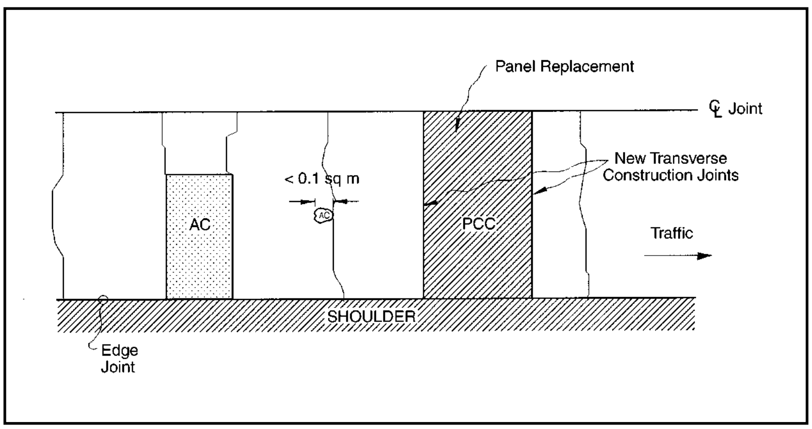


FIGURE 118
Distress Type CRCP 11—Patch/Patch Deterioration

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.

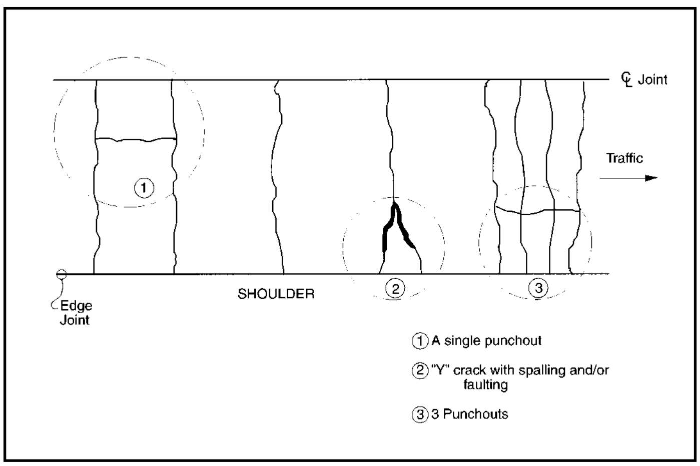


FIGURE 123
Distress Type CRCP 12—Punchouts

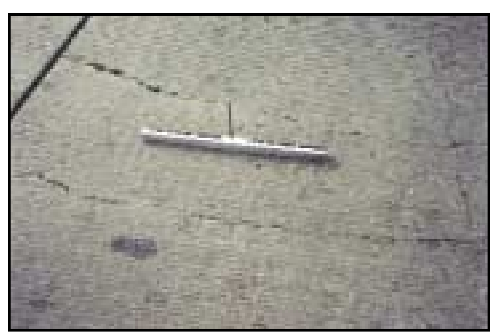


FIGURE 124
Distress Type CRCP 12—Low Severity Punchout

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.

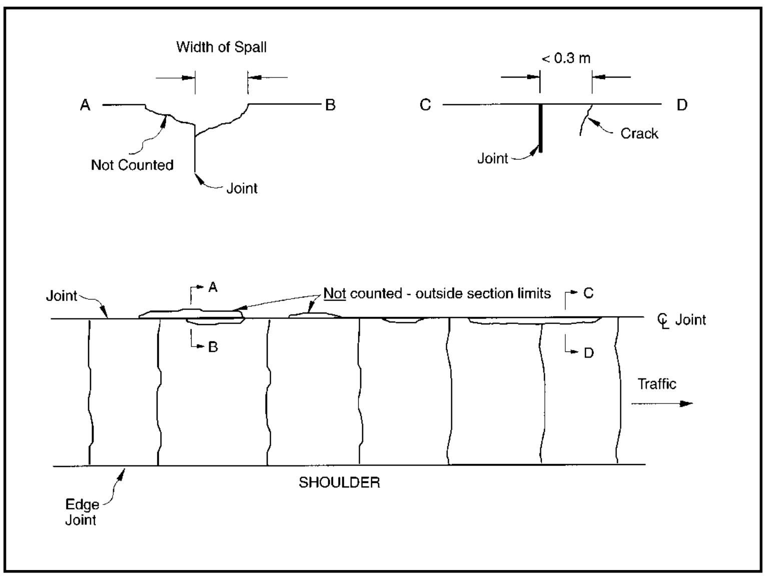


FIGURE 127
Distress Type CRCP 13—Spalling of Longitudinal Joints

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

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

Glossary

ADHESIVE FAILURE
loss of bond (e.g., between the joint sealant and the joint reservoir; between the aggregate and the binder)

AGGREGATE INTERLOCK
interaction of aggregate particles across cracks and joints to transfer load

APPROACH SLAB
section of pavement just prior to joint, crack, or other significant roadway feature relative to the direction of traffic (see also leave slab)

BINDER
brown or black adhesive material used to hold stones together for paving

BITUMINOUS
like or from asphalt

BLEEDING
identified by a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflective surface that may be tacky to the touch in warm weather

BLOCK CRACKING
the occurrence of cracks that divide the asphalt surface into approximately rectangular pieces, typically 0.1 m^2 or more in size

BLOWUP
the result of localized upward movement or shattering of a slab along a transverse joint or crack

CENTERLINE
the painted line separating traffic lanes

CHIPPING
breaking or cutting off small pieces from the surface

COHESIVE FAILURE
the loss of a material's ability to bond to itself. Results in the material splitting or tearing apart from itself (i.e., joint sealant splitting)

CONSTRUCTION JOINT
the point at which work is concluded and reinitiated when building a pavement

CORNER BREAK
a portion of a jointed concrete pavement separated from the slab by a diagonal crack intersecting the transverse and longitudinal joint, which extends down through the slab, allowing the corner to move independently from the rest of the slab

DURABILITY CRACKING
the breakup of concrete due to freeze-thaw expansive pressures within certain aggregates. Also called "D" cracking

EDGE CRACKING
fracture and materials loss in pavements without paved shoulders which occurs along the pavement perimeter. Caused by soil movement beneath the pavement

EXTRUSION
to be forced out (i.e., joint sealant from joint)

FATIGUE CRACKING
a series of small, jagged, interconnecting cracks caused by failure of the AC surface under repeated traffic loading (also called alligator cracking)

FAULT
difference in elevation between opposing sides of a joint or crack

FREE EDGE
pavement border that is able to move freely

HAIRLINE CRACK
a fracture that is very narrow in width, less than 3 mm

JOINT SEAL DAMAGE
any distress associated with the joint sealant, or lack of joint sealant

LANE LINE
boundary between travel lanes, usually a painted stripe

LANE-TO-SHOULDER DROPOFF
the difference in elevation between the traffic lane and shoulder

LANE-TO-SHOULDER SEPARATION
widening of the joint between the traffic lane and the shoulder

LEAVE SLAB
section of pavement just past a joint, crack, or other significant roadway feature relative to the direction of traffic

LONGITUDINAL
parallel to the centerline of the pavement

MAP CRACKING
a series of interconnected hairline cracks in PCC pavements that extend only into the upper surface of the concrete. Includes cracking typically associated with alkali-silica reactivity

PATCH
an area where the pavement has been removed and replaced with a new material

PATCH DETERIORATION
distress occurring within a previously repaired area

POLISHED AGGREGATE
surface mortar and texturing worn away to expose coarse aggregate in the concrete

POPOUTS
small pieces of pavement broken loose from the surface

POTHOLE
a bowl-shaped depression in the pavement surface

PUMPING
the ejection of water and fine materials through cracks in the pavement under moving loads

PUNCHOUT
a localized area of a CRCP bounded by two transverse cracks and a longitudinal crack. Aggregate interlock decreases over time and eventually is lost, leading to steel rupture and allowing the pieces to be punched down into the subbase and subgrade

RAVELING
the wearing away of the pavement surface caused by the dislodging of aggregate particles

REFLECTION CRACKING
the fracture of AC above joints in the underlying jointed concrete pavement layer(s)

RUTTING
longitudinal surface depressions in the wheelpaths

SCALING
the deterioration of the upper 3-12 mm of the concrete surface, resulting in the loss of surface mortar

SHOVING
permanent, longitudinal displacement of a localized area of the pavement surface caused by traffic pushing against the pavement

SPALLING
cracking, breaking, chipping, or fraying of the concrete slab surface within 0.6 m of a joint or crack

TRANSVERSE
perpendicular to the pavement centerline

WATER BLEEDING
seepage of water from joints or cracks

WEATHERING
the wearing away of the pavement surface caused by the loss of asphalt binder

A

MANUAL FOR DISTRESS SURVEYS

TABLE OF CONTENTS

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.

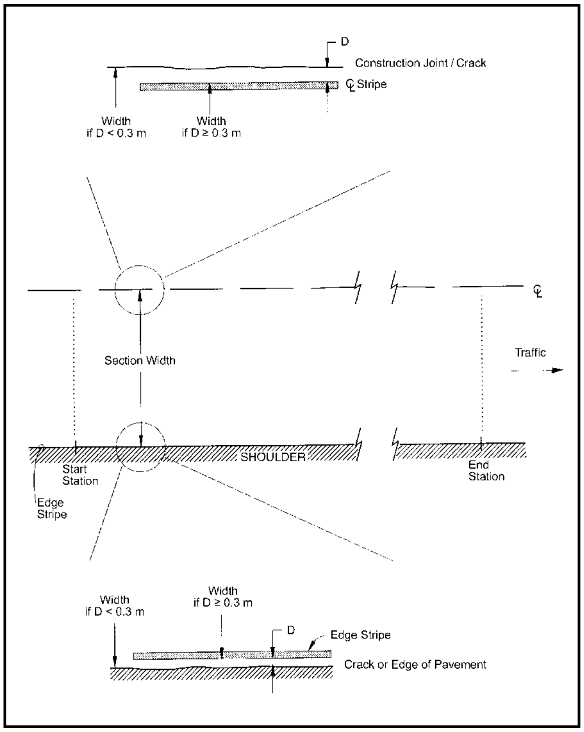


FIGURE A1
Test Section Limits for Surveys—
Asphalt Surface

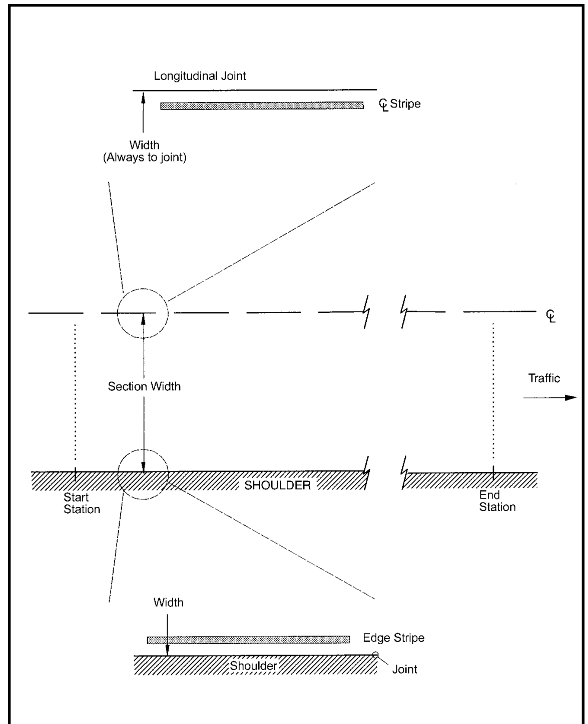


FIGURE A2
Test Section Limits for Surveys—
Concrete Surface

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

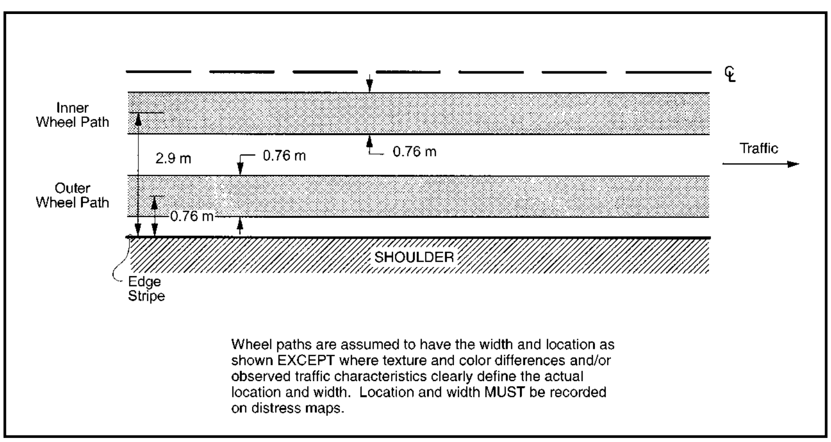


FIGURE A3
Locating Wheel Paths in Asphalt Concrete-Surfaced Pavements

DISTRESS SURVEYS

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.

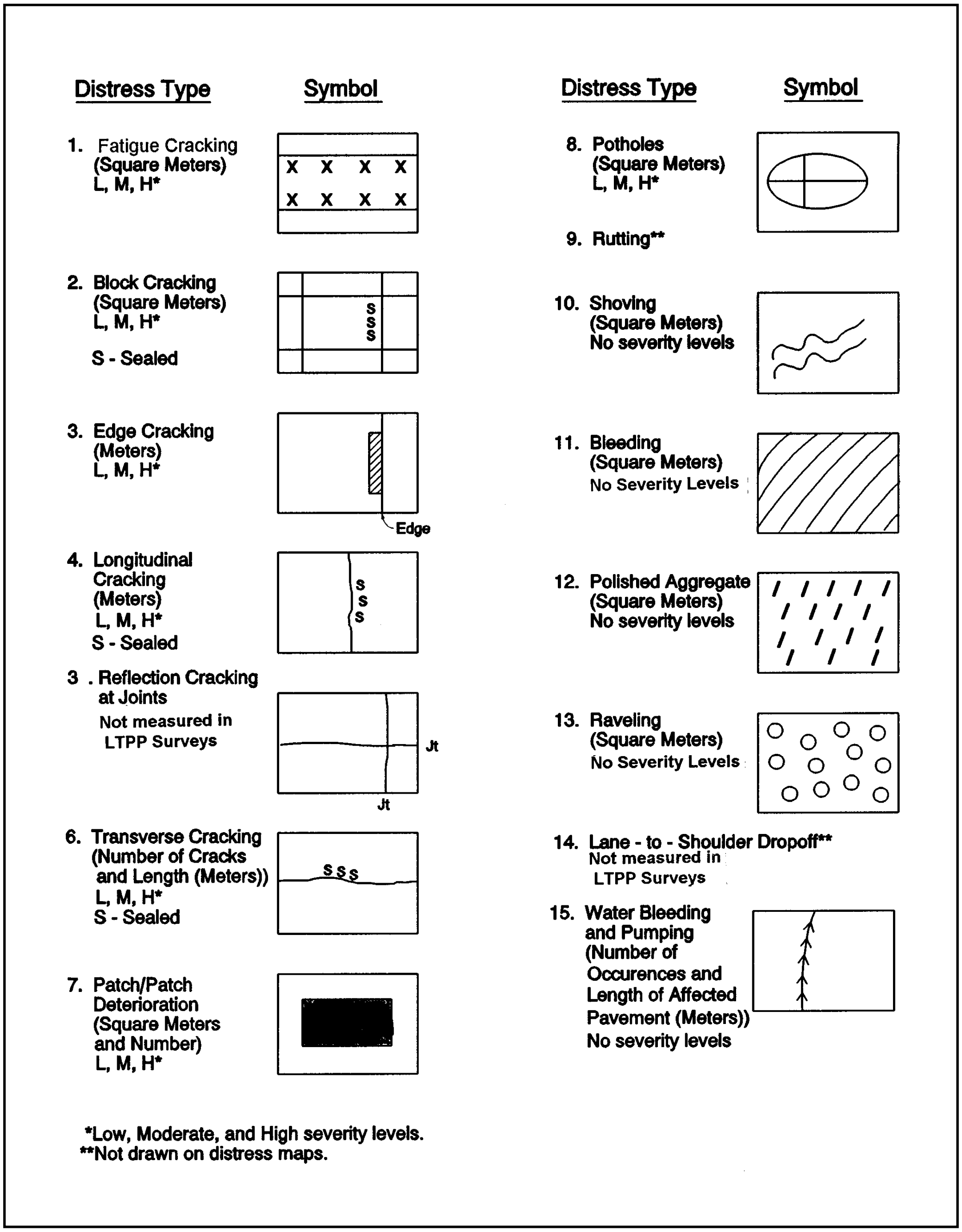


FIGURE A4
Distress Map Symbols for Asphalt Concrete-Surfaced Pavements

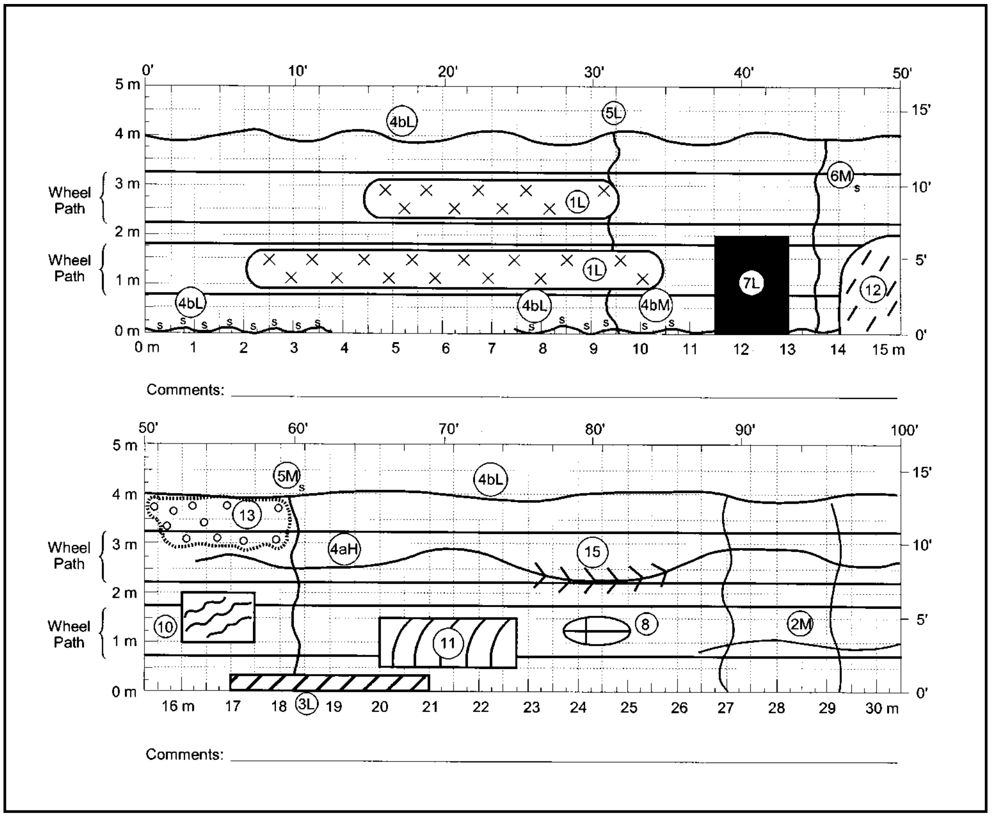


FIGURE A5
Example Map of First 30.5 meters of Asphalt Concrete Pavement Section

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.

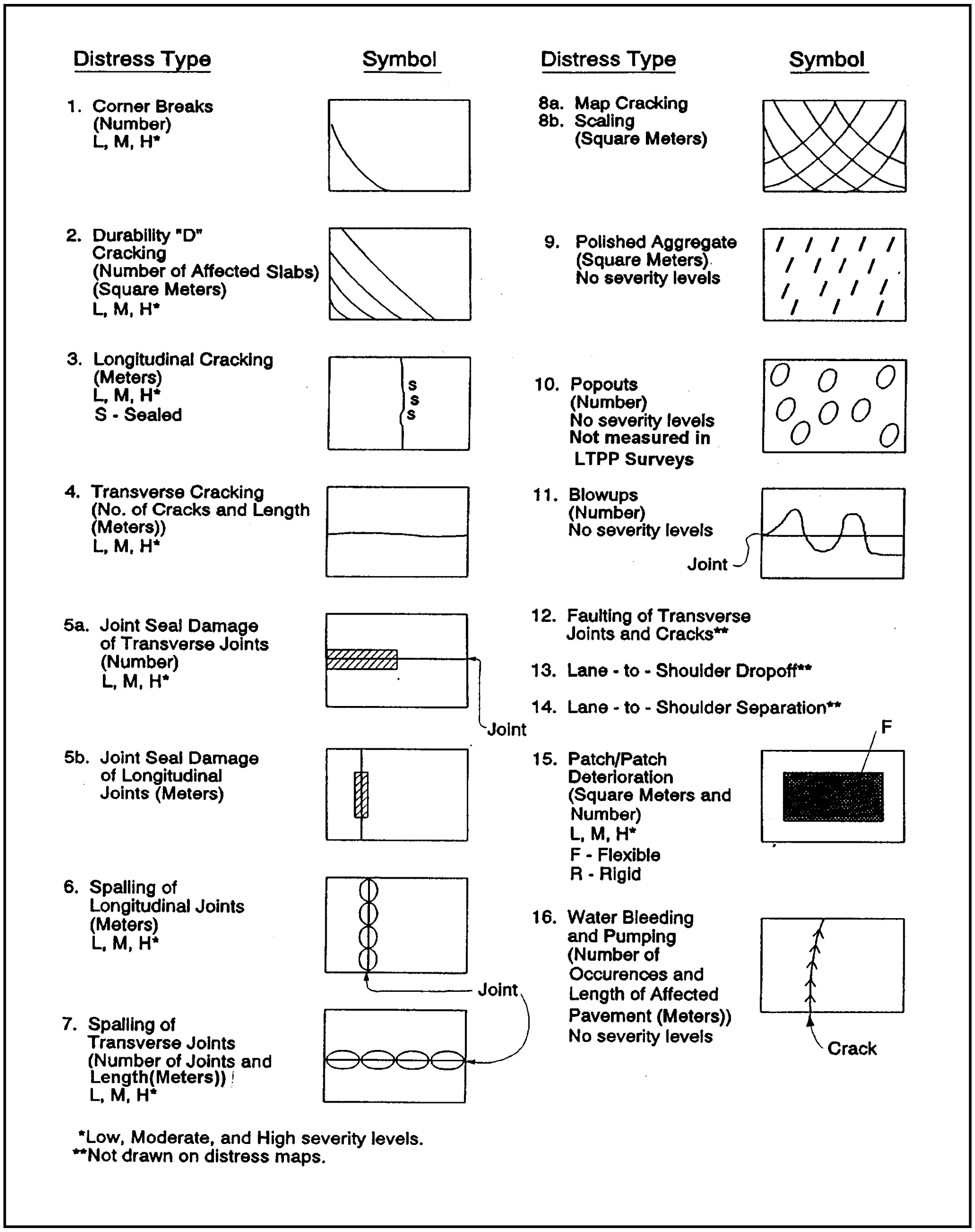


FIGURE A6
Distress Map Symbols for Jointed Concrete Pavements

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.

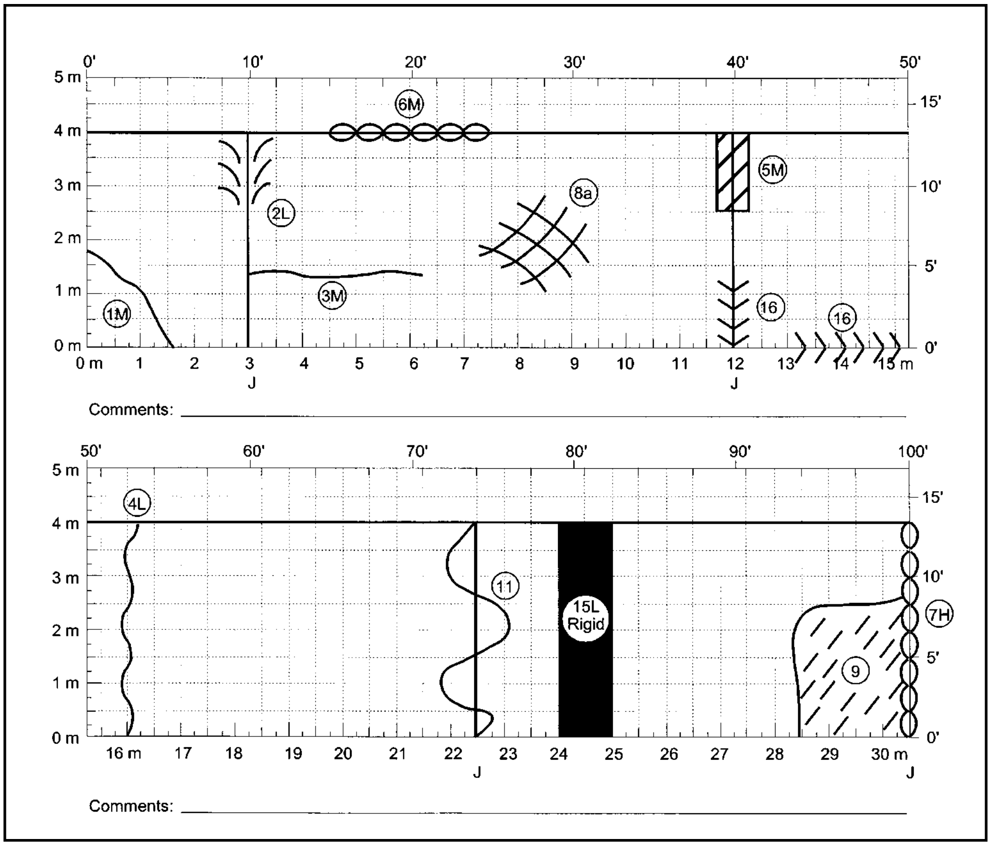


FIGURE A7
Example Map of First 30.5 meters of a Jointed Concrete Pavement Section

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.

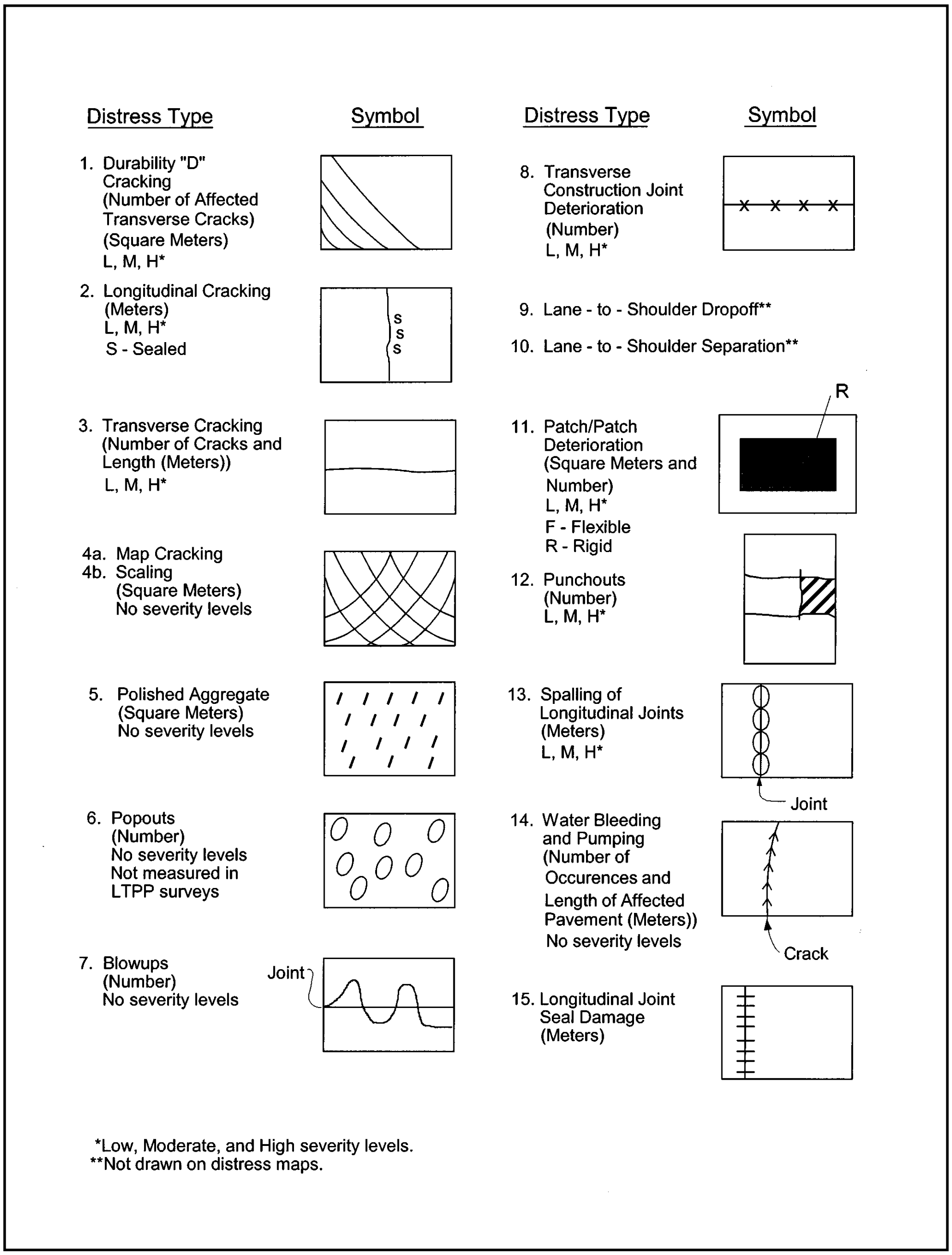


FIGURE A8
Distress Map Symbols for Continuously Reinforced Concrete Pavements

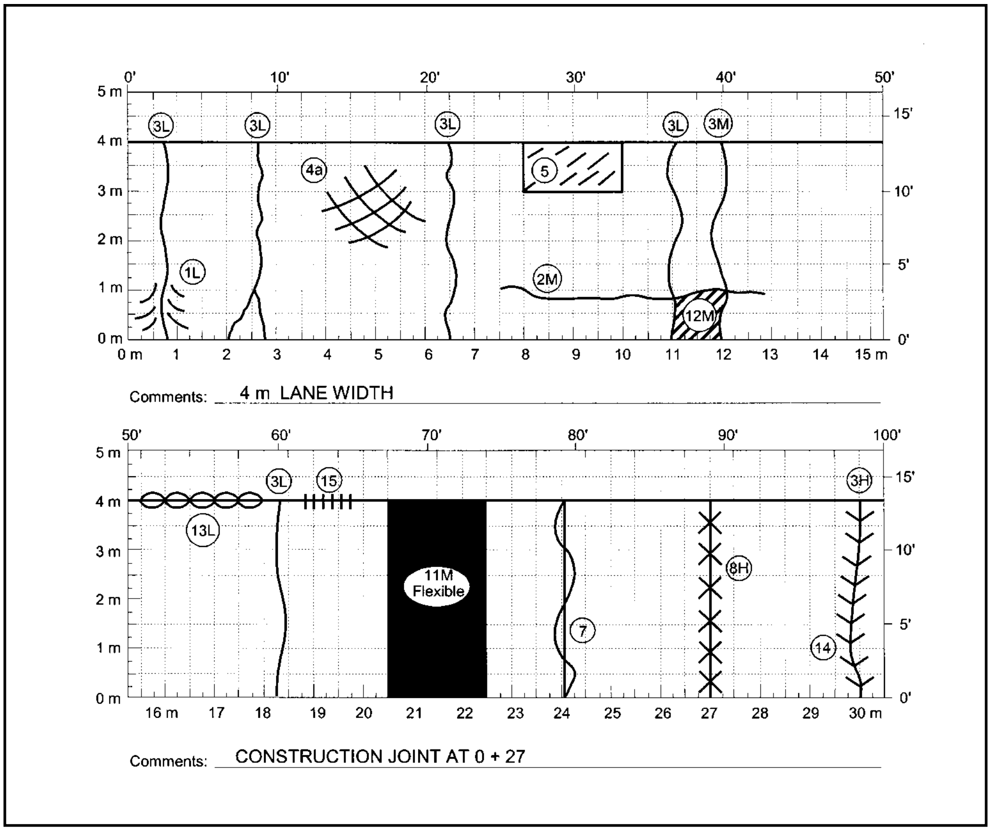


FIGURE A9
Example Map of First 30.5 meters of a Continuously Reinforced Concrete Pavement Section

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.

Reviewer: MRC
Date: 06/25/92

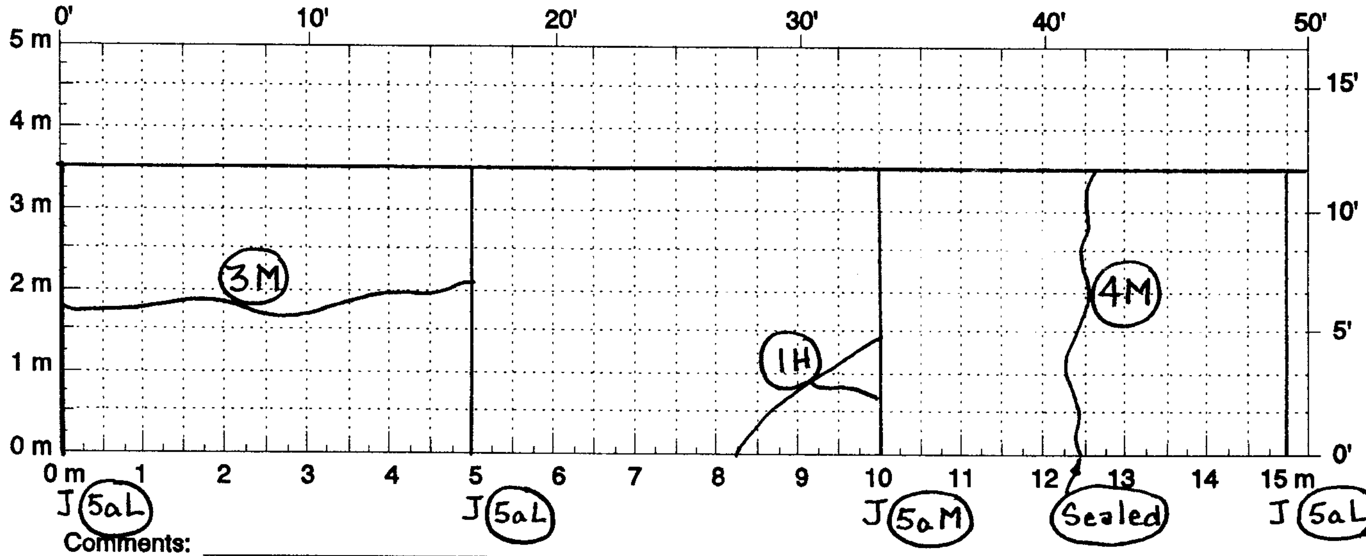
Surveyors: JSR, EJF
Date: 06/12/92

Pavement Temp:
Before 18°C After 19°C

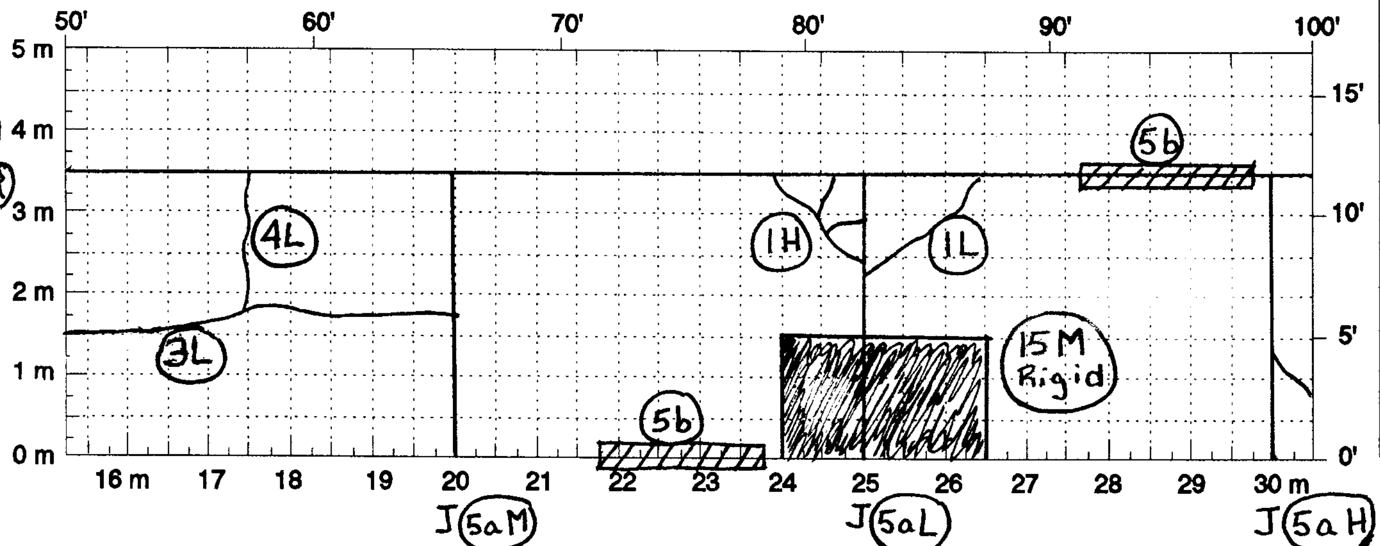
State Assigned ID 1234
State Code 28
SHRP Section ID 0101

Section Summary

1L – 1
1H – 3
3L – 4.8
3M – 9.3
4L – 1.8 (1)
4M – 3.5 (1)
5aL – 8
5aM – 4
5aH – 2
5b – 4
8b – 2 (1)
15L – 7 (1) R
15M – 21.3 (2) R
16 – 4.5 (2)
2 "L" Joints sealed



Comments:



Comments:

Sheet Summary

1L – 1
1H – 2
3L – 4.75
3M – 5
4L – 1.75
4M – 3.5 S
5aL – 4
5aM – 2
5aH – 1
5b – 4
15M – 3.75 R

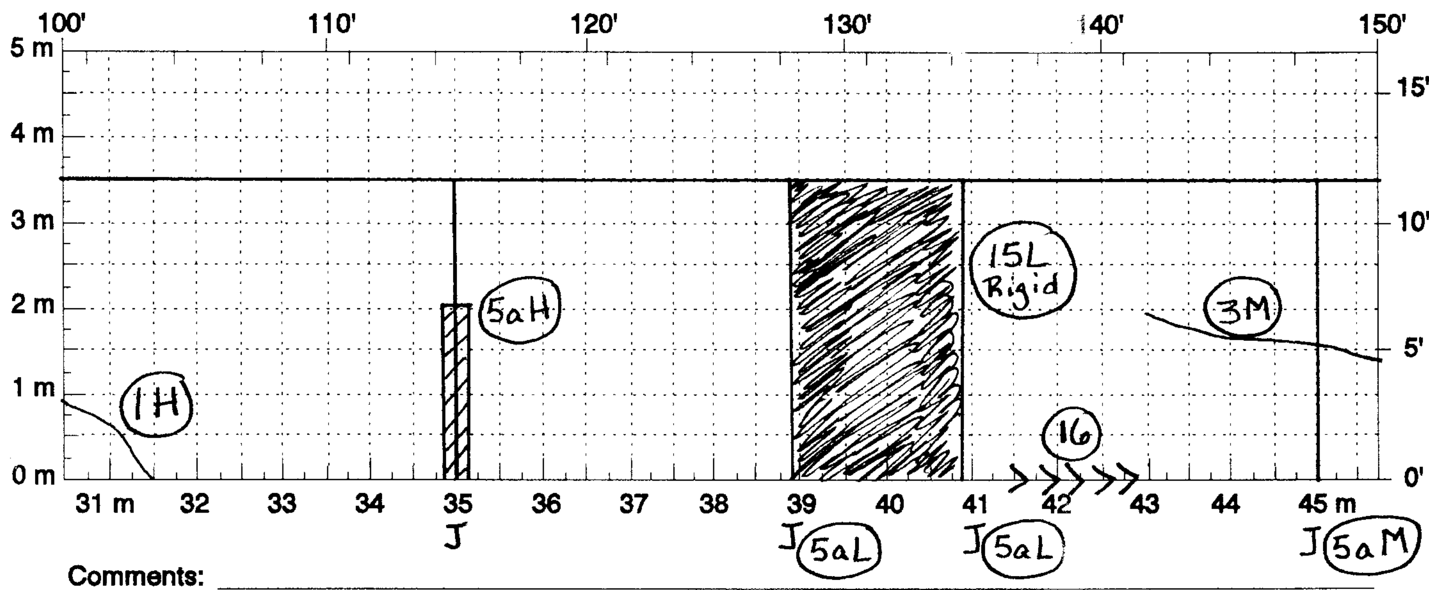
Reviewer: MRC Date: 06/25/92

Surveyors: JSR, EJF Date: 06/12/92

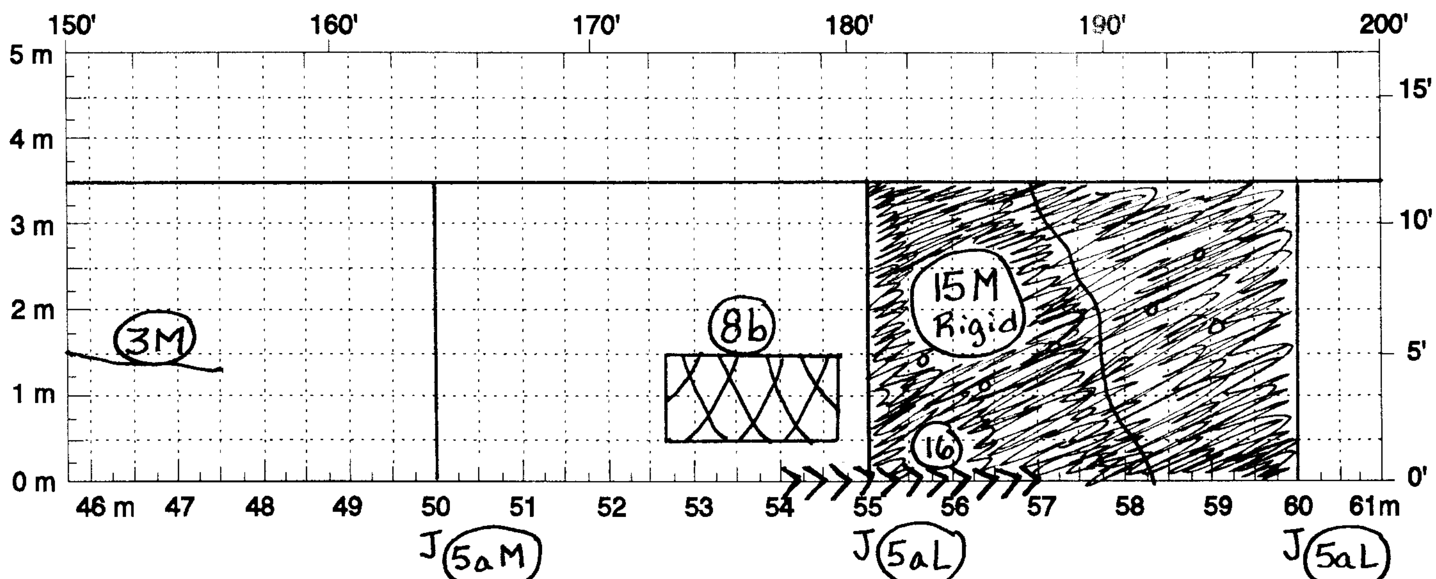
State Assigned ID 1234

State Code 28

SHRP Section ID 0101



Comments:



Comments:

Sheet Summary

1H - 1
3M - 4.25
5aL - 4
5aM - 2
5aH - 1
8b - 2
15L - 7 R
15M - 17.5 R
16 - 4.5 (2)

Revised May 29, 1992

SHEET 4

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID 1 2 3 4

STATE CODE 2 8

SHRP SECTION ID Ø 1 Ø 1

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) Ø 6/1 2/9 2

SURVEYORS: J S R, E J F, __ __ __
PAVEMENT SURFACE TEMP - BEFORE __ __ 1 8 °C; AFTER __ __ 1 9 °C
PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) P

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	1	Ø	3
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	Ø	Ø	Ø
AREA AFFECTED (Square Meters)	Ø.Ø	Ø.Ø	Ø.Ø
3. LONGITUDINAL CRACKING (Meters)	4.8	9.2	Ø.Ø
Length Sealed (Meters)	Ø.Ø	Ø.Ø	Ø.Ø
4. TRANSVERSE CRACKING (Number of Cracks)	1	1	Ø
(Meters)	1.8	3.5	Ø.Ø
Length Sealed (Meters)	Ø.Ø	3.5	Ø.Ø
JOINT DEFICIENCIES			
5a. TRANSVERSE JOINT SEAL DAMAGE Sealed? (Y, N)			Y
If "Y" Number of Joints	8	4	2
5b. LONGITUDINAL JOINT SEAL DAMAGE Number of Longitudinal Joints that have been sealed (0, 1, or 2)			2
Length of Damaged Sealant (Meters)			4.Ø
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	Ø.Ø	Ø.Ø	Ø.Ø
7. SPALLING OF TRANSVERSE JOINTS Number of Affected Joints	Ø	Ø	Ø
Length Spalled (Meters)	Ø.Ø	Ø.Ø	Ø.Ø

SHEET 5

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE 28

SHRP SECTION ID Φ1Φ1

DATE OF DISTRESS SURVEY (MONTH/ DAY/ YEAR) 06/12/92

SURVEYORS: JSR, EJF

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

DISTRESS TYPE	LOW	MODERATE	HIGH
	SEVERITY LEVEL		
SURFACE DEFORMATION			
8a. MAP CRACKING (Number)			Φ
(Square Meters)			Φ.Φ
8b. SCALING (Number)			1
(Square Meters)			2.Φ
9. POLISHED AGGREGATE (Square Meters)			Φ.Φ
10. POPOUTS Not Recorded			
MISCELLANEOUS DISTRESSES			
11. BLOWUPS (Number)			Φ
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)	Φ	Φ	Φ
(Square Meters)	Φ.Φ	Φ.Φ	Φ.Φ
Rigid (Number)	1	2	Φ
(Square Meters)	7.Φ	31.3	Φ.Φ
16. WATER BLEEDING AND PUMPING (Number of occurrences)			2
Length Affected (Meters)			4.5
17. OTHER (Describe)			

Revised April 23, 1993

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID 1 2 3 4

STATE CODE 2 8

SHRP SECTION ID Ø 1 Ø 1

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) Ø 6/1 2/9 2
SURVEYORS: J S R, E J F

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

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Page 1 of 1

Point[1] Distance (Meters)	Joint or Crack (J/C)	Crack Length (Meters)	Well Sealed (Y/N)	Length of Joint Spalling, m			Faulting[2], mm	
				L	M	H	0.3m	0.75m
Ø.1	J	_._	_	Ø._	Ø._	Ø._	Ø	Ø
5.Ø	J	_._	_	Ø._	Ø._	Ø._	3	4
1Ø.Ø	J	_._	_	Ø._	Ø._	Ø._	2	3
12.3	C	3.5	Y	_._	_._	_._	2	1
15.Ø	J	_._	_	Ø._	Ø._	Ø._	1	2
2Ø.Ø	J	_._	_	Ø._	Ø._	Ø._	4	5
25.Ø	J	_._	_	Ø._	Ø._	Ø._	3	2
3Ø.Ø	J	_._	_	Ø._	Ø._	Ø._	1	Ø
35.Ø	J	_._	_	Ø._	Ø._	Ø._	1	Ø
38.8	J	_._	_	Ø._	Ø._	Ø._	5	-4
4Ø.8	J	_._	_	Ø._	Ø._	Ø._	3	-4
45.Ø	J	_._	_	Ø._	Ø._	Ø._	2	3
5Ø.Ø	J	_._	_	Ø._	Ø._	Ø._	1	Ø
55.Ø	J	_._	_	Ø._	Ø._	Ø._	1	Ø
6Ø.Ø	J	_._	_	Ø._	Ø._	Ø._	Ø	1
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
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_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _
_ _ _._	_	_._	_	_._	_._	_._	_ _ _	_ _ _

Note 1. Point Distance is from the start of 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.

Revised May 29, 1992

SHEET 7

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID 1 2 3 4

STATE CODE 2 8

SHRP SECTION ID Ø 1 Ø 1

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) Ø 6/1 2/9 2
SURVEYORS: J S R, E J F

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

13. LANE-TO-SHOULDER DROPOFF

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.	_ _ 4.	_ _ 8.	Y
2.	15.25	_ _ 8.	_ _ 6.	Y
3.	30.5	_ _ Ø.	_ 1 Ø.	Y
4.	45.75	_ _ 6.	_ _ 8.	Y
5.	61.	_ _ _.	_ _ _.	_
6.	76.25	_ _ _.	_ _ _.	_
7.	91.5	_ _ _.	_ _ _.	_
8.	106.75	_ _ _.	_ _ _.	_
9.	122.	_ _ _.	_ _ _.	_
10.	137.25	_ _ _.	_ _ _.	_
11.	152.5	_ _ _.	_ _ _.	_

NOT MAPPED

Note 1. Point Distance is from the start of the test section to the measurement location. The values shown are SI 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 (+) signs, positive values are assumed.

Blank Distress Map Forms and Data Sheets

These map forms and data sheets may be photocopied from this book for field use. Note that each type of pavement has its own data sheets.

Reviewer: ______

Date: ___________

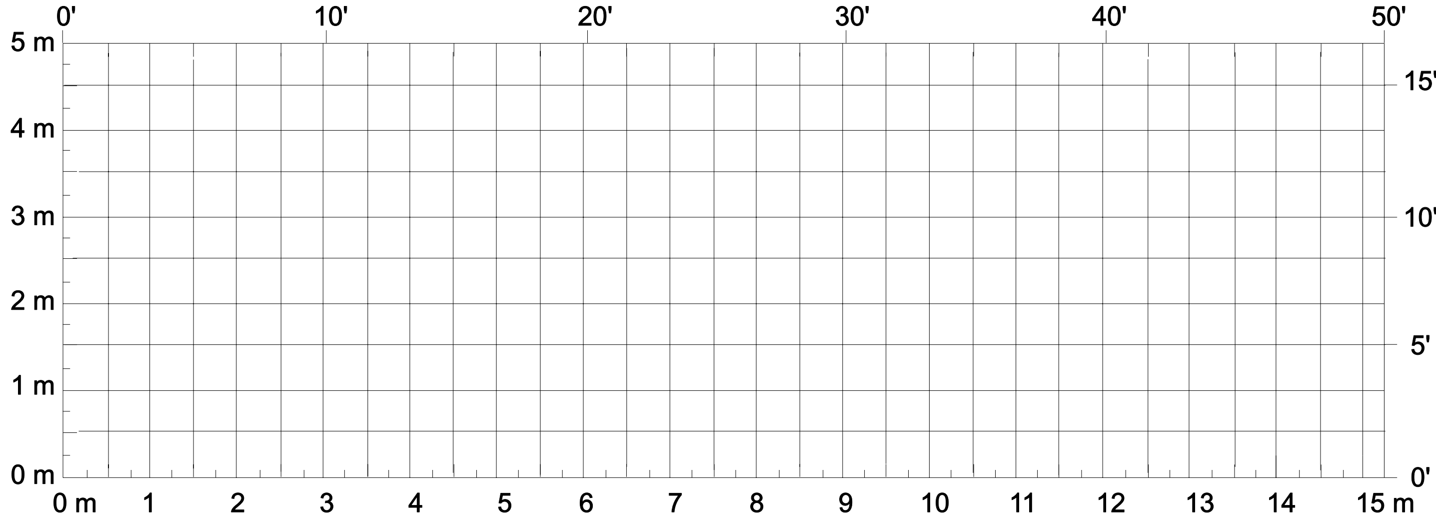
Surveyors: ______

Date: ___________

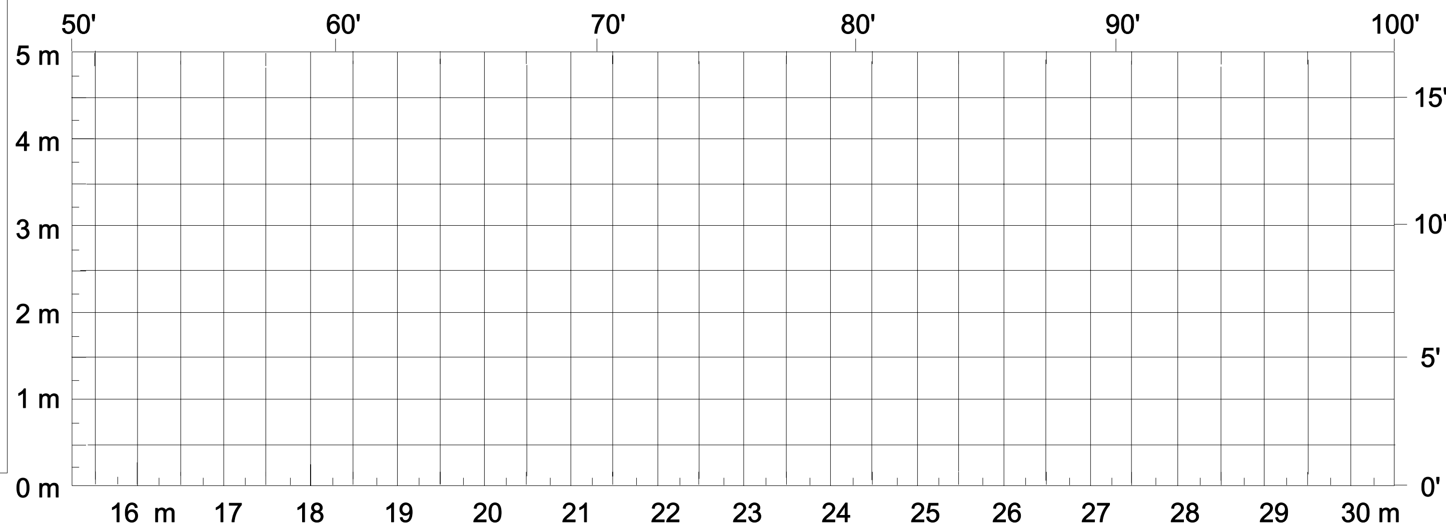
Pavement Temp:

Before_______ After_______

Section Summary



Comments: ____________________

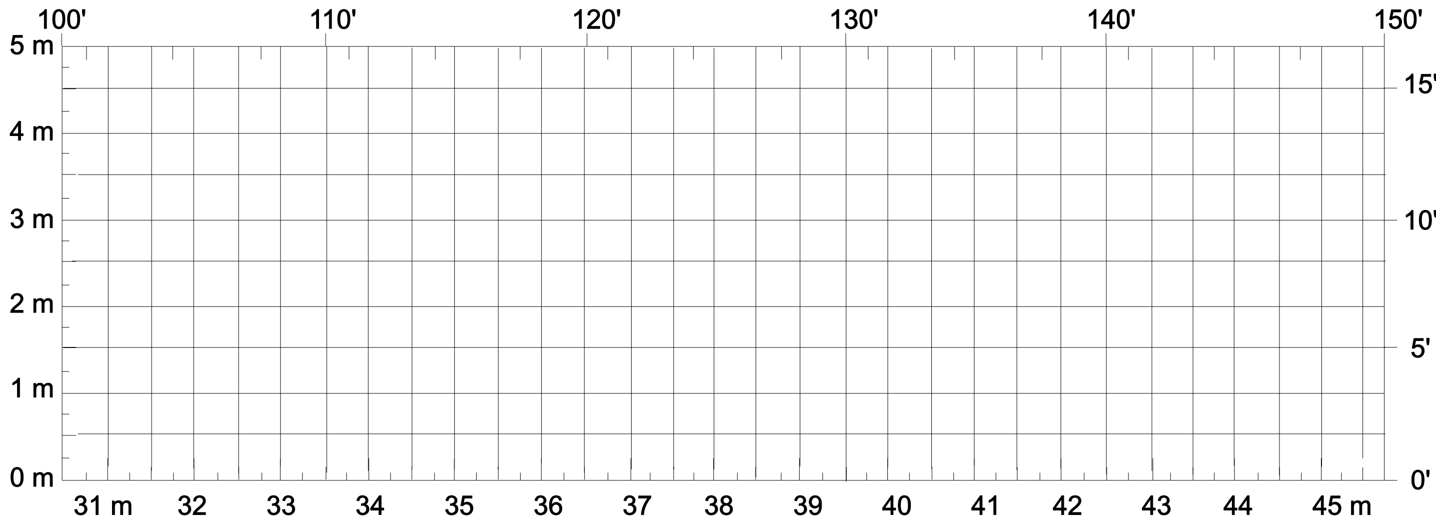


Comments: ____________________

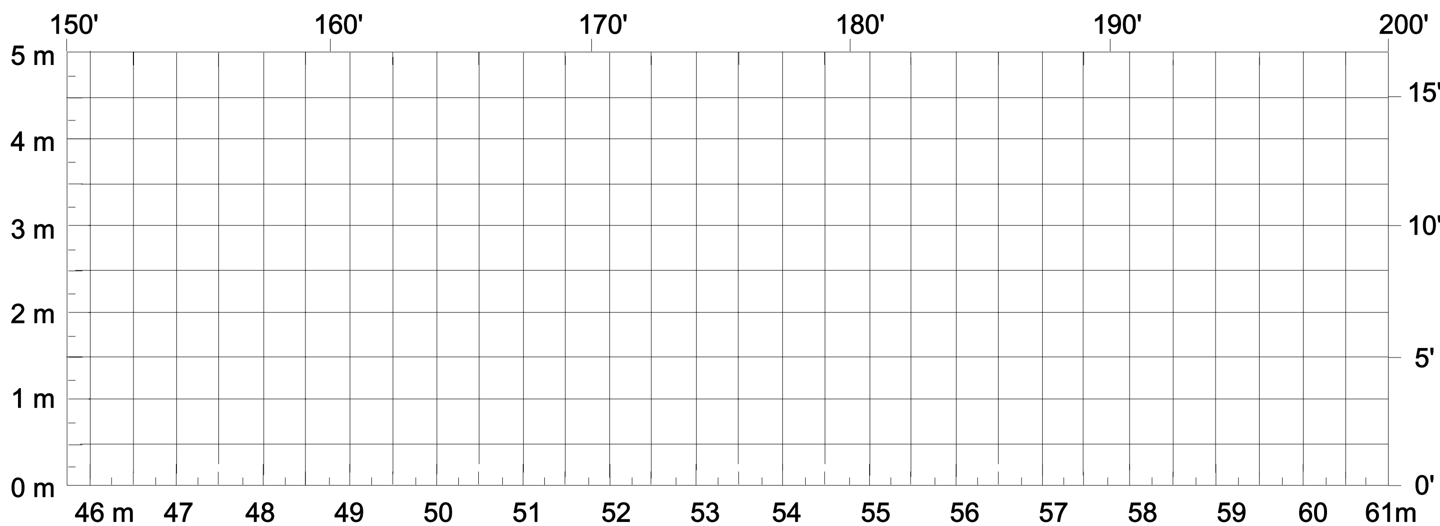
Sheet Summary

Reviewer: ______ Surveyors: ______

Date: ___________ Date: ___________



Comments: ______________________________

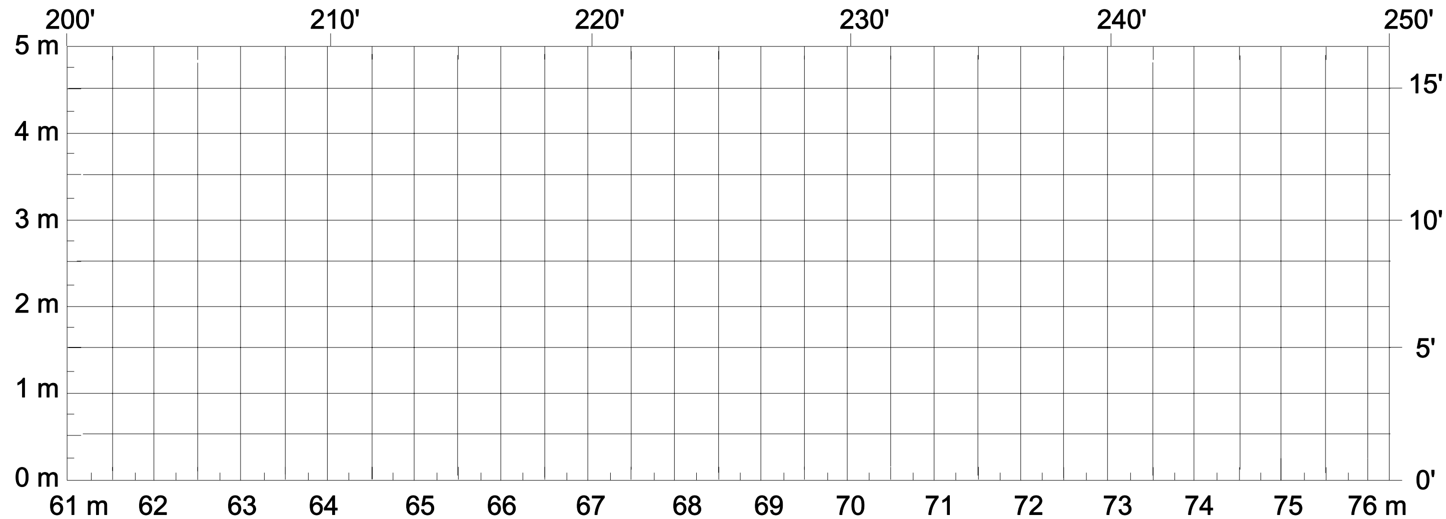


Comments: ______________________________

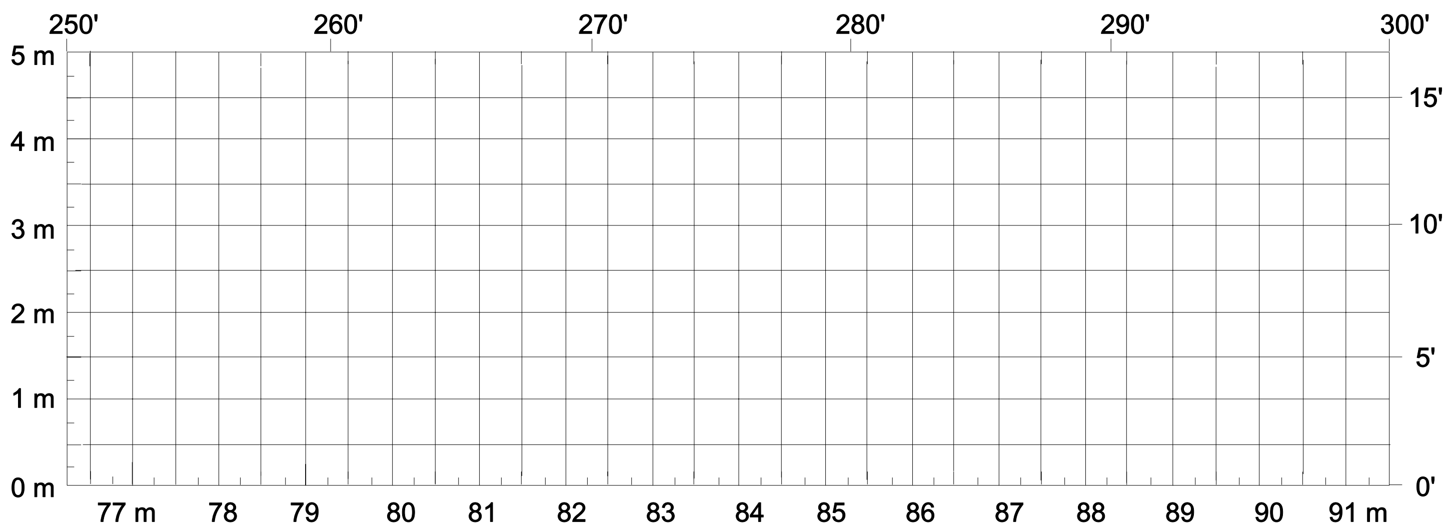
Sheet Summary

Reviewer: ______ Surveyors: ______

Date: ___________ Date: ___________



Comments: ______________________________

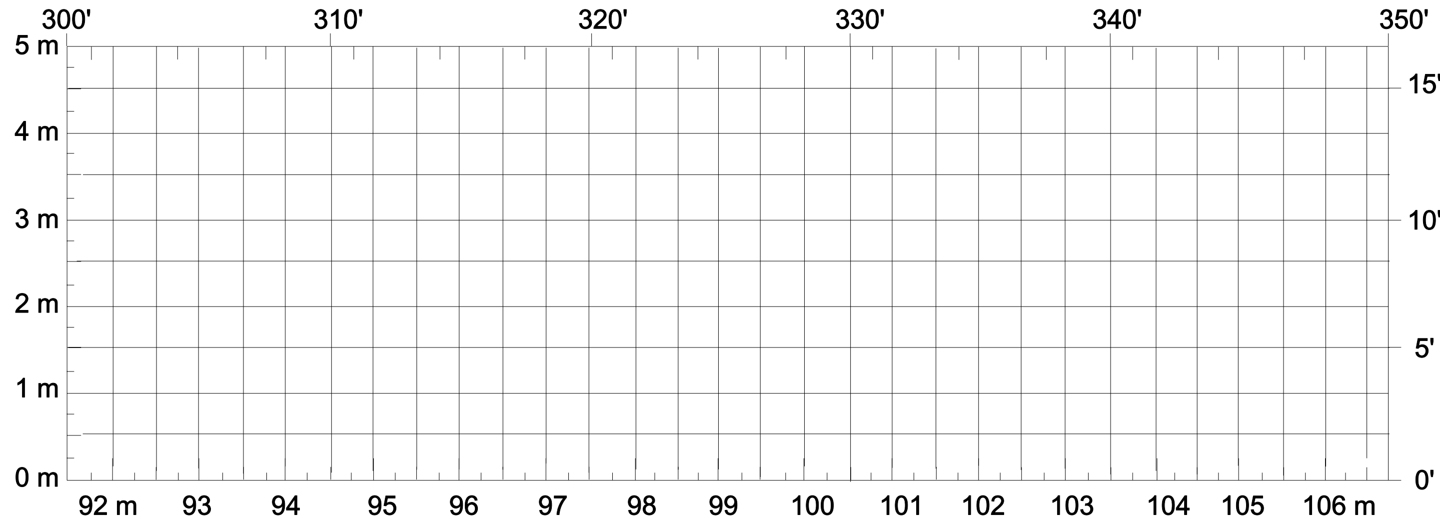


Comments: ______________________________

Sheet Summary

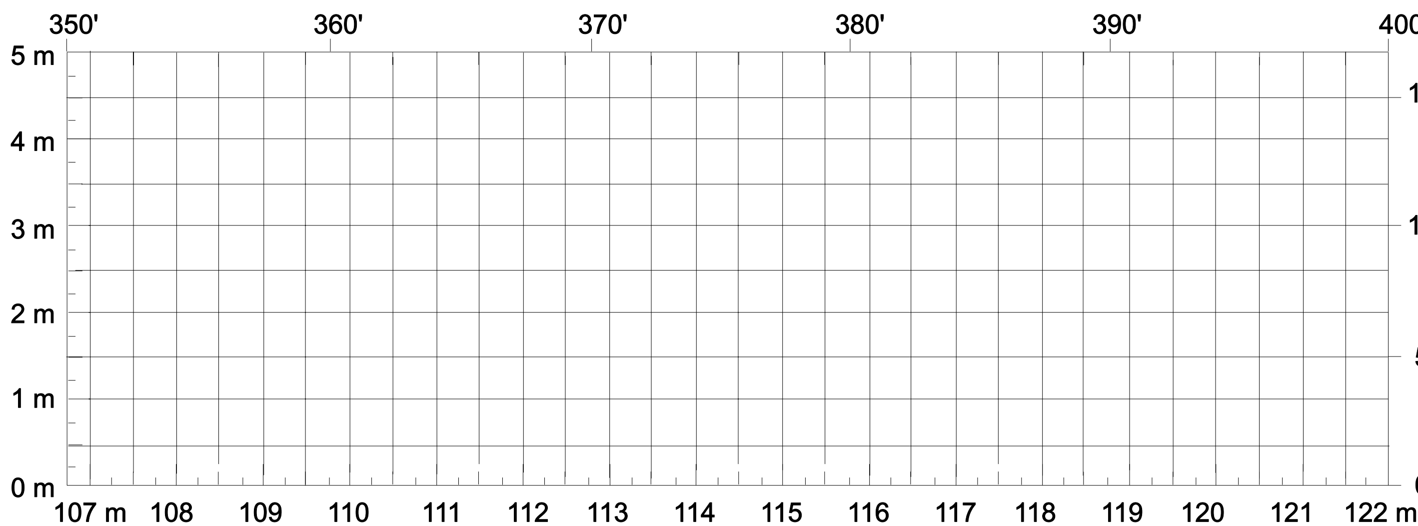
Reviewer: ______ Surveyors: ______

Date: ___________ Date: ___________



Sheet Summary

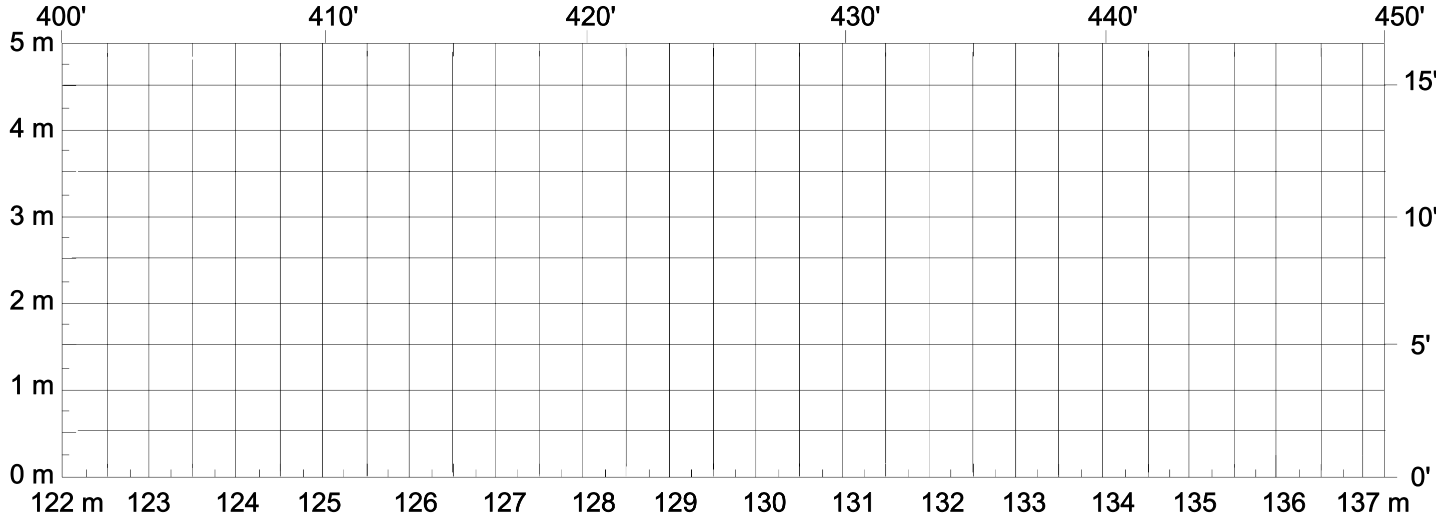
Comments: ___________



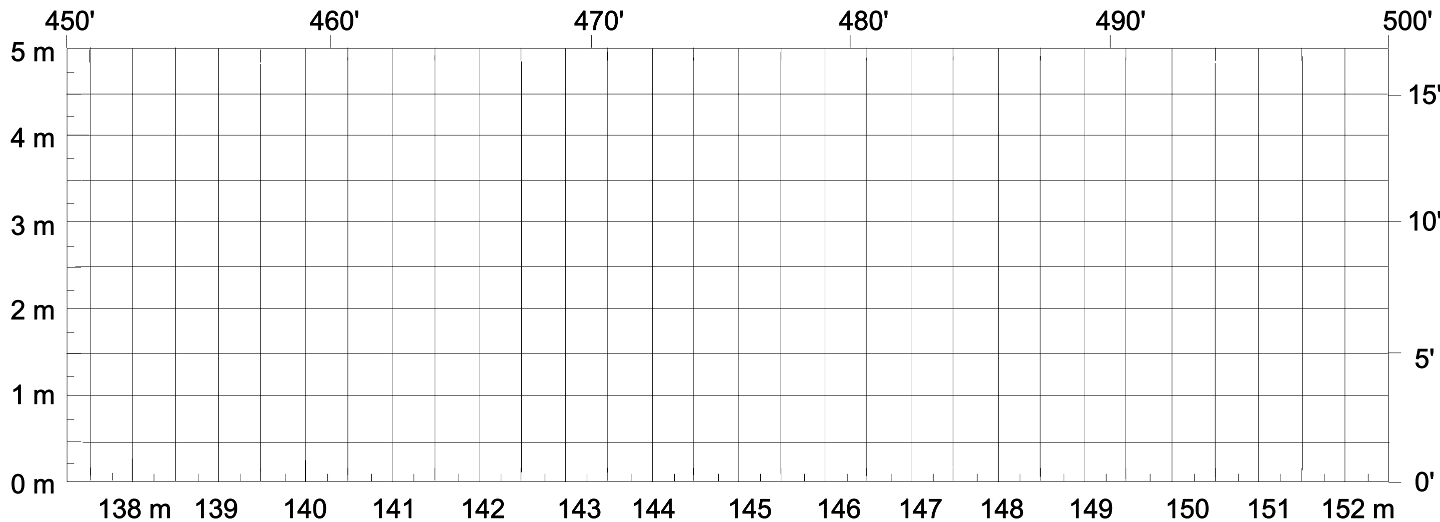
Comments: ___________

Reviewer: ______ Surveyors: ______ Pavement Temp:

Date: ___________ Date: ___________ After_______



Comments: ____



Comments: ____

Sheet Summary

Revised Dec 1992; Jan 1999; Feb 2002

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP SECTION ID __ __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT 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

	SEVERITY LEVEL		
DISTRESS TYPE	LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (SQUARE METERS)	__ __ __.__	__ __ __.__	__ __ __.__
2. BLOCK CRACKING (SQUARE METERS)	__ __ __.__	__ __ __.__	__ __ __.__
3. EDGE CRACKING (METERS)	__ __ __.__	__ __ __.__	__ __ __.__
4. LONGITUDINAL CRACKING			
4a.Wheelpath (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Length Sealed (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
4b.Non-Wheelpath(Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Length Sealed (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
5. REFLECTION CRACKING AT JOINTS	Not Recorded		
6. TRANSVERSE CRACKING Number of Cracks	__ __ __	__ __ __	__ __ __
Length (Meters)	__ __ __.__	__ __ __.__	__ __ __.__
Length Sealed	__ __ __.__	__ __ __.__	__ __ __.__
PATCHING AND POTHOLES			
7. PATCH/ PATCH DETERIORATION (Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__
8. POTHOLES (Number)	__ __ __	__ __ __	__ __ __
(Square Meters)	__ __ __.__	__ __ __.__	__ __ __.__

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP ID __ __ __ __

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

SURVEYORS: __ __ __, __ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
9. RUTTING - REFER TO SHEET 3 FOR SPS - 3 FOR FORM S1 SEE DIPSTICK MANUAL			
10. SHOVING			
(Number)			__ __ __
(Square Meters)			__ __ __.__
SURFACE DEFECTS			
11. BLEEDING			
(Square Meters)			__ __ __.__
12. POLISHED AGGREGATE			
(Square Meters)			__ __ __.__
13. RAVELING			
(Square Meters)			__ __ __.__
MISCELLANEOUS DISTRESSES			
14. LANE-TO-SHOULDER DROPOFF - NOT RECORDED			
15. WATER BLEEDING AND PUMPING			
(Number)			__ __ __
Length of Affected Pavement (Meters)			__ __ __.__
16. OTHER (Describe)			

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE __ __

SHRP ID __ __ __ __

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

SURVEYORS:__ __ __,__ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

9. RUTTING (FOR SPS-3 SURVEYS)

INNER WHEEL PATH			OUTER WHEEL PATH		
Point No.	Point Distance[1] (Meters)	Rut Depth (mm)	Point No.	Point Distance[1] (Meters)	Rut Depth (mm)
1	0.0	__ __ __	1	0.0	__ __ __
2	15.25	__ __ __	2	15.25	__ __ __
3	30.5	__ __ __	3	30.5	__ __ __
4	45.75	__ __ __	4	45.75	__ __ __
5	61.0	__ __ __	5	61.0	__ __ __
6	76.25	__ __ __	6	76.25	__ __ __
7	91.5	__ __ __	7	91.5	__ __ __
8	106.75	__ __ __	8	106.75	__ __ __
9	122.0	__ __ __	9	122.0	__ __ __
10	137.25	__ __ __	10	137.25	__ __ __
11	152.5	__ __ __	11	152.5	__ __ __

14. LANE-TO-SHOULDER DROPOFF -- Not Recorded

Note 1: "Point Distance" is the distance in meters for the start of the test section to the point where the measurement was made. The values shown are approximate S1 equivalents of the 50 ft spacing used in previous surveys.

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) ______________________________

____

Revised April 23, 1993; September 1998; June 1999

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.

Revised May 29, 1992

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.

Revised December 30, 1992; September 1998

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			

Revised May 29, 1992

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.

C

PROFILE MEASUREMENTS USING THE FACE DIPSTICK®

TABLE OF CONTENTS

PROFILE MEASUREMENTS USING THE FACE DIPSTICK®

C.1 INTRODUCTION

The Face Company Dipstick is a manually operated device that collects precision profile measurements at rates greater than traditional rod and level survey procedures. However, the profile obtained from Dipstick measurements may have a shift from the true profile because of systematic cumulative errors in the Dipstick readings. The body of the Dipstick houses an inclinometer (pendulum), liquid crystal display panels, and a battery for power supply. The Dipstick sensor is mounted in such a way that its axis and line passing through footpad contact points are coplanar. The sensor becomes unbalanced as the Dipstick is pivoted from one leg to the other as it is moved down the pavement, causing the display to become blank. After the sensor achieves equilibrium, the difference in elevation between the two points is displayed. Swivel footpads with a diameter of 32 mm should be used for all measurements.

Each LTPP Regional Support Contractor (RSC) has two Dipsticks; a manual Dipstick (Model 1500) and an automated Dipstick (Model 2000). Both these Dipsticks display data in millimeters. The spacing between the two feet of the Dipstick is 305 mm for both models. When the automated Dipstick is used for data collection, it should be used in manual mode, with data recorded manually.

Profile measurements on General Pavement Studies (GPS) and SPS sites that cannot be obtained using the LTPP profiler should be completed using the Dipstick. Decisions with respect to the need for Dipstick measurements at these test sections should be made on a case-by-case basis by responsible RSC personnel.

C.2 OPERATIONAL GUIDELINES

C.2.1 General Procedures

Dipstick measurements are to be taken by personnel who have been trained in using the device and are familiar with the procedures described in this manual. Data collection using the Dipstick is a two-person operation, with one person operating the Dipstick and the other person recording the data. However, a single person can collect the data if that person uses a voice activated tape recorder to record the readings.

The RSC must coordinate detailed scheduling and traffic control at test sites. Traffic control at test sites will be provided by either the State highway agency (in the United States) or Provincial highway agency (in Canada). Layout of site should not begin until all applicable traffic control equipment is in place.

C.2.2 LTPP Procedures

Record Maintenance: The operator is responsible for forwarding all data collected during testing (see forms at the end of this appendix). In addition, the operator must forward other records related to Dipstick operation, which are described in section C.6, to the RSC.

Equipment Repairs: RSCs are responsible for ensuring that LTPP-owned equipment is properly maintained. Decisions required for proper maintenance and repair should be made based on testing schedule and expedited as necessary to prevent testing disruptions.

Accidents: In the event of an accident, inform the RSC of the incident as soon as possible after the mishap, and provide details of the event in writing to the RSC.

C.3 FIELD TESTING

C.3.1 General Background

The following sequence of field work tasks and requirements provides an overall perspective of the typical work day at a test section.

Task 1: **Personnel Coordination**

a: Dipstick crew (operator and recorder)

b: Traffic control crew supplied by State highway agency or traffic control contractor working for the State agency (as recommended by State highway agency or Provincial highway agency)

c: Other LTPP, State DOT, and RSC personnel (they are observers and are not required to be present)

Task 2: **Site Inspection**

a: Assess general pavement condition (within test section limits)

b: Identify wheel paths

Task 3: **Dipstick Measurements**

a: Mark wheel paths

b: Perform operational checks on Dipstick

c: Obtain Dipstick measurements

d: Ensure quality control

Task 4: Complete forms DS-1 through DS-7 for longitudinal profile measurements. Complete form DS-8 for transverse profile measurements. These forms are included at the end of this appendix.

When arriving at a site, the operator should plan activities carefully to ensure the most efficient use of time. While many activities can be accomplished only by the operator and/or recorder, it may be necessary to enlist other personnel at the site to mark wheel paths. In general, the RSC should make arrangements for this assistance in advance.

If a manual distress survey also is performed at the site, traffic control typically should be available for 6 to 8 hours. This should provide adequate time for Dipstick measurements in both wheel paths, as well as for the manual distress survey to be completed. Experienced Dipstick operators can obtain approximately 500 readings/hour.

Collecting profile data is the operator's primary responsibility. To ensure that data collected in the four LTPP regions are identical in format, certain guidelines and standards have been established for data acquisition and handling.

C.3.2 Site Inspection and Layout—Longitudinal Profile Measurements

The pavement must be clear of ice, snow, and puddles of water before profile measurements can be taken with the Dipstick, as such conditions can affect profile measurements. Pools of water can damage electronics in the Dipstick and must be avoided, either through adjusting profiling trip schedules, or by delaying actual measurements until acceptable conditions exist.

The longitudinal Dipstick measurement procedure consists of performing an elevation survey in each wheel path and using transverse measurements at the section ends to form a closed loop. As illustrated in figure C1, measurements start at Station 0+00 in the right wheel path and proceed in the direction of traffic toward the end of the section. At the end of the section, transverse measurements are made to the end point of the survey line in the left wheel path. A 0.61 m diameter closure circle around this point is used to close transverse measurements on this start location for measurements in the left wheel path. Longitudinal measurements then are performed in the left wheel path back to Station 0+00. Transverse measurements and a closure circle close the survey on the starting point. This procedure is designed for a 152.4 m test section; however, the concept can be applied to test sections of any length.

To begin Dipstick measurements, clean both wheel paths of loose stones and debris to prevent Dipstick footpad slippage during measurements. The first step in the site layout is to locate the wheel paths; each wheel path is located at a distance of 0.826 m from the center of the travel lane. Use the following procedure to locate the center of the travel lane:

Case I: Where wheel paths are easily identified, the midway point between two wheel paths should be used as the lane center.

Case II: If wheel paths are not clearly identifiable, but two lane edges are well-defined, the center of the travel lane is considered to be midway between the two lane edges.

Case III: Where wheel paths are not apparent and only one lane edge can be distinguished clearly, establish the lane center at 1.83 m from that edge.

After the center of the travel lane has been identified, use the following procedure to layout the site:

1. Identify the location of two longitudinal elevation survey lines 0.826 m from center of lane. Mark these locations at intervals equal to the length of the chalk line used for marking. Use the chalk line to mark a straight line between previously established points. The "start" should be located so that the back edge of the Dipstick footpad is located immediately adjacent to the leave edge of the white stripe at the beginning of the monitoring portion of the test section. If this location is not marked with a stripe, establish the start location at Station 0+00. Using a tape measure (measuring wheels are not acceptable), carefully measure length of each longitudinal elevation

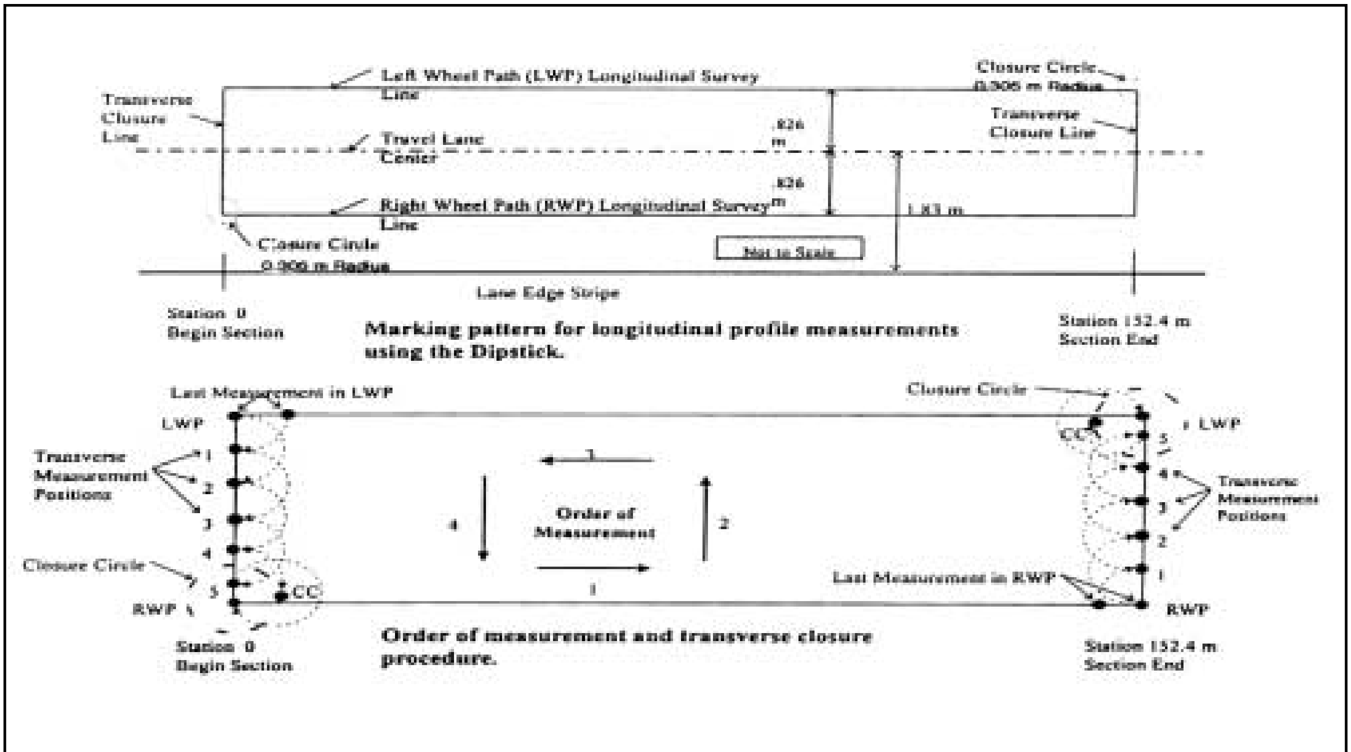


FIGURE C1
Longitudinal Profile Measurement with Dipstick—Site Layout and Measurement Procedure

survey line to establish end points at 152.4 m (or at specified length for test sections that are not 152.4 m long) from the previously established start location. An accurate measurement of this length is required, because it is used as a quality control check on the measurement process.

2. At Station 0+00, use a chalk line to mark a transverse line connecting the end points of the two longitudinal elevation survey lines. In right wheel path, mark a 0.61 m-diameter circle centered on the first measurement point. This closure circle will be used to complete the elevation survey loop.

3. At the end point marks placed at Station 152.4 m, or at the end of the test section, use a chalk line to mark a transverse line connecting the end points of the longitudinal elevation survey lines. Mark a 0.61 m diameter circle centered on the measurement point located in the left wheel path at this location. This closure circle will be used to complete the elevation survey loop.

4. On the data collection sheet or field notebook, note the method used to establish the lane center location and any discrepancies between painted and measured section end locations. This information will help collect consistent data in future profile measurements at that section.

C.3.3 Dipstick Operation for Longitudinal Profile Measurements

C.3.3.1 Pre-operational Checks on Dipstick

Checks to be performed on the Dipstick before testing are described in this section.

1. Check condition of footpads and replace, if necessary, with the extra set in the Dipstick case. Clean and lubricate ball and socket joints on the footpads to insure smooth pivoting of instrument. When joint is dirty, pivoting becomes difficult, and the footpad can slip. A cleaning agent such as WD-40 or a light oil for lubrication will work for the ball and socket joint.
2. If using Model 1500 Dipstick, install a fresh set of rechargeable batteries in the instrument and securely close battery compartment. The batteries in this unit have to be taken out in order to recharge them. The Model 2000 Dipstick is equipped with rechargeable batteries that can be charged while the batteries are still within the unit. If the batteries have not been charged overnight, install a fresh set of rechargeable batteries in the instrument and securely close battery compartment. Batteries in either of these units should be changed after 4 hours of usage to insure continuity of measurements. The Model 1500 Dipstick is powered with 9-volt batteries, while the Model 2000 Dipstick is powered with AA-size batteries. An extra set of rechargeable batteries should be kept available for each of these units.
3. Check and if necessary, tighten the handle on the instrument.
4. Perform zero check and calibration check, described below. According to the manufacturer, a calibration check is needed only if adjustments were required during the zero check. However, for LTPP-related measurements, both the zero and calibration checks are required when data collection begins. The Dipstick should be fully assembled, turned on, and allowed to warm up for several minutes before performing these two checks.

Manual Dipstick (Model 1500)

Zero Check (Model 1500)

Form DS-7 should be completed when this test is conducted. This test performs a zero verification. Perform the test on a smooth, clean location where the instrument can be positioned properly (the Dipstick carrying case or a flat board will suffice). After positioning the Dipstick, draw two circles around the footpads and note the reading on the display at the switch end (reading = R1). Then rotate the instrument 180° and place the footpads on the two circles that were drawn earlier; note the reading obtained at the switch end (reading = R2). If readings from the two placements (R1 and R2) add up to within +0.1 mm, the Dipstick has passed the zero check. If they do not fall within these limits, zero adjustment is necessary. The zero adjustment should be performed using the following procedure:

1. Obtain average of two Dipstick readings; e = 0.5 (R1 + R2).
2. Subtract average value from R2 reading to obtain R2o; R2o = R2 – e.
3. Loosen the set screw with the Dipstick still in R2 reading position, and adjust start/end pin up or down so that the display reads R2o.
4. Tighten set screw, rotate the Dipstick back to R1 reading position, and read display at switch end (reading = R1o).

5. Check to make sure the addition of R1o and R2o readings are within tolerance; if not, repeat adjustment procedure until the two readings are within tolerance.

This is the only adjustment the operator is allowed to make on the Dipstick.

Calibration Check (Model 1500)
Dipstick calibration is fixed during manufacturing and cannot be altered by the user. The user can verify calibration against a standard calibration block that is provided with the Dipstick. After zero check and adjustments are performed, device calibration must be checked. Form DS-7 should be completed when this test is conducted. To check calibration, note the Dipstick reading and place the 3.2 mm calibration block under one of the Dipstick footpads. The reading displayed, minus 3.2, should be within +0.1 mm of the previous reading. If this tolerance is not obtained, complete a LTPP Major Maintenance/Repair Activity Report (form DS-10 at the end of this appendix) and contact the manufacturer through the RSC office to repair the Dipstick.

Automated Dipstick (Model 2000)
Zero Check (Model 2000)
This check should be performed on a smooth, clean and stable location (carrying case for the Dipstick or a flat board will suffice) where the instrument can be properly positioned. Draw circles around the two footpads and depress the CAL button once. Then rotate the instrument 180° and place the two footpads in the circles drawn earlier. Depress the CAL button once again. The display will flash "CAL" three times, after which the error is automatically stripped out of the readings. Note the reading at the switch end of Dipstick. Rotate the Dipstick and place two footpads in the circles, and note the reading at the switch end. If the two readings add up to within +0.1 mm, the Dipstick has passed the zero check. The zero check can be performed only once. If the check is not successful, the Dipstick must be turned off, turned back on, and the zero check repeated. A checkmark should be placed on form DS-7 at the appropriate location to indicate that the zero check was performed.

Calibration Check (Model 2000)
Follow procedure described for the manual Dipstick (Model 1500) to perform this check. Complete form DS-7 when this test is conducted.

C.3.3.2 Longitudinal Profile Measurement
Complete header information on form DS-1. Follow these procedures to collect longitudinal profile data using the Dipstick.

1. To start profile measurement, place the Dipstick on the marked survey line in the right wheel path at Station 0+00, with "start" arrow pointed forward in direction of traffic.

2. After the reading stabilizes, record it under the right wheel path column on form DS-2 on the row corresponding to "Reading Number 1." Rotate the Dipstick clockwise to the next measuring point. After the reading has stabilized, record it on the next row of form DS-2 labeled "Reading Number 2." Repeat this procedure for the entire length of the test section. While measuring, follow these precautions and procedures:

(a) Always use a clockwise rotation.

(b) Hold the Dipstick handle vertically when taking measurements.

(c) Do not apply lateral pressure to the handle during a measurement.

(d) Avoid placing the footpad where it might fall into a wide crack or a pothole in the pavement. If this happens, offset the footpad placement so it will rest on the pavement that is adjacent to the crack or pothole.

(e) If for any reason measurements must be stopped, draw circles around both footpads, with the "start" arrow in the direction of traffic at last measurement position. When restarting, return the Dipstick to this position and adjust it so that the current measurement agrees with the measurement before stopping.

(f) If it is not possible to mark the footpad positions before stopping, or to reposition the Dipstick successfully in the same position, then discard the data and restart the measurement procedure from the beginning.

3. After the last measurement in right wheel path at Station 152.4 m, compare the location of the front Dipstick foot to the pre-measured end point location. If the front foot is within 152 mm of the marked end point location, proceed with transverse closure measurements as indicated in step 4. If front foot is not within this interval, perform the following:

(a) Draw circles around each foot and note direction of start arrow.

(b) Check data sheets for skipped or missing measurements.

(c) If no apparent anomalies are present in data, remeasure length of longitudinal survey line to verify position of end point. If the remeasured end point location is within 152 mm of the Dipstick's front foot, re-mark the transverse line at this location and proceed. If the end point is not within 152 mm of the Dipstick's front foot, discard data as suspect and restart the survey from Station 0+00.

4. After location of last measurement in right wheel path has been verified, initiate transverse closure measurements by rotating the rear foot of the Dipstick toward the left wheel path and placing it on the pre-marked transverse closure line. Measurements along the transverse closure line should be recorded in the table labeled "Transverse Closure Measurements from Right Wheel Path to Left Wheel Path at Station 152.4 m," located at the bottom of form DS-6. When the Dipstick reaches the point at which the next measurement along the transverse survey line passes the left wheel path's location, rotate the device so that the footpad rests at any point on the closure circle (CC). After recording this measurement in the column labeled "5-CC," rotate the device so that the footpad rests on top of the intersection between the longitudinal survey line in the left wheel path and the transverse closure line. Record this measurement under "CC-LWP." This procedure is illustrated in figure C1.

5. Begin measurements down the longitudinal survey line in the left wheel path, recording them in the column labeled "LWP" on forms DS-6 through DS-2. These measurements will be entered in reverse order from those in the "RWP" column.

6. When the last measurement in the left wheel path is made at Station 0+00, verify that the position of the front Dipstick foot is within 152 mm of the end point. If not, follow procedures for end point verification previously discussed for the measurements in right wheel path. If a problem is found with a missing or skipped measurement or final location of Dipstick in left wheel path, discard measurements in the left wheel path as suspect and restart the survey at the beginning point in the left wheel path.

7. After verifying location of the last measurement in the left wheel path, initiate transverse closure measurements by rotating the rear foot of the Dipstick toward the right wheel path and placing it on the pre-marked transverse closure line. Measurements along the transverse closure line should be recorded in the table labeled "Transverse Closure Measurements from Left Wheel Path to Right Wheel Path at Station 0+00," located at the bottom of form DS-2. When the Dipstick reaches the point in which the next measurement along the transverse survey line passes the right wheel path's location, rotate it so that the footpad rests at any point on the CC. After recording this measurement in the column labeled "5-CC," rotate the device so that the footpad rests on the intersection between the longitudinal survey line in the right wheel path and the transverse closure line. Record this measurement under "CC-RWP." This procedure is illustrated in figure C1.

C.3.3.3. Post-data Collection Check

After completing the survey, the operator must conduct the zero and calibration checks. For the manual Dipstick (Model 1500), obtain readings R1 and R2 as described in "zero check" in section C.3.3.1. Readings from the two placements (R1 and R2) should add up to within + 0.1 mm to pass the zero check. If the addition of the two readings is outside these limits, the device has failed the zero check.

For the automated Dipstick (Model 2000), place the Dipstick on a smooth, clean, and stable location (the Dipstick carrying case or a flat board will suffice) where the instrument can be positioned properly. Draw circles around the two footpads, and note reading at the switch end of the instrument (R1). Then rotate the instrument 180° and place the two footpads in the circles that were drawn earlier. Note the reading at the switch end of the Dipstick (R2). The two readings (R1 and R2) should add up to within + 0.1 mm in order to pass the zero check. If the addition of the two readings is outside these limits, the device has failed the zero check.

For both the manual Dipstick (Model 1500) and automated Dipstick (Model 2000), the calibration check should be performed as described in section C.3.3.1 for the manual Dipstick.

Enter the results from these checks form DS-7. Based on results from these checks, follow one of the applicable procedures presented below:

1. If Dipstick fails zero check, discard the data as suspect and perform another survey.

2. If Dipstick passes zero check but fails calibration check, discard the data as suspect and contact the manufacturer for repair, as discussed under "calibration check" in section C.3.3.1 of this manual.

3. If Dipstick passes both tests, perform the closure error computations described in section C.3.3.4.

If Dipstick fails the zero check, but can be adjusted to pass the zero cheek and also passes the calibration check, perform another survey.

C.3.3.4 Closure Error Computations

Follow these procedures when performing closure error computations.

1. Perform closure error computations in the field before leaving the site.
2. Sum the readings in each column on forms DS-2 through DS-6 and record in the last row of each column. Add the measurements in transverse closure measurement tables on forms DS-2 and DS-6 across the row and enter the results in the last column.
3. Enter column summations onto form DS-1 in locations corresponding to labels shown in each summation cell.
4. Add the elevation sums in the "RWP" and "LWP" columns on form DS-1, and record the result in indicated cells.
5. Add transverse sums to each of these sums, and record the result in the "total" row at the bottom of the closure calculation table.
6. Sum the two totals and enter the result into the cell labeled "closure error."
7. If the closure error is not within ±76 mm, discard the data as suspect and resurvey the test section until the closure error is within allowable limits.

C.3.4 Site Inspection and Layout—Transverse Profile Measurements

Pavement must be clear of ice, snow, and puddles of water before profile measurements can be taken with the Dipstick, as such conditions can affect profile measurements. Pools of water can damage electronics in the Dipstick and must be avoided by either adjusting profiling trip schedules or delaying actual measurements until acceptable conditions exist. Layout and mark straight lines for transverse profile measurements. Lines shall be perpendicular to edge of pavement and located at 15.24 m intervals, starting at station 0 and ending at station 152.4 m (or end of section if the test section length is not 152.4 m). For each test section (GPS or SPS), 11 transverse lines will be present. Adjust line locations to avoid pavement markings and other anomalies such as patches and potholes. Record the need for and magnitude of such adjustments on appropriate data sheets. Perform transverse profile measurements when conducting manual surveys on asphalt-surfaced pavements. Transverse profile measurements are not required for rigid pavements.

C.3.5 Dipstick Operation for Transverse Profile Measurements

C.3.5.1 Pre-operational Checks on Dipstick

The operator should check equipment using procedures described in section C.3.3.1. Checks will include both the zero and calibration checks. The operator should complete the LTPP Dipstick Data Collection Form (DS-7).

C.3.5.2 Entering Header Information in Transverse Profile Form

After performing the pre-operational checks on the equipment, the operator should complete the header information in the Transverse Profile Data Collection Form (DS-8). The header fields that should be completed in this form, as well as guidelines for completing these fields, are provided in this section. As this information is used in ProQual, it is important that the operator follow these guidelines when filling the header information.

State Code: State code of State in which the site is located.

LTPP Section ID: Four-digit LTPP section ID of site.

Date: Current date.

Time: Current time; use military format (e.g., 09:30, 15:30).

Dipstick Serial #: Five-digit serial number on base or side of Dipstick (e.g., 30021).

Dipstick Model #: 1500 for manual model and 2000 for automated model (new unit).

Operator: First and last initials of operator in capital letters (e.g., JD).

Recorder: First and last initials of recorder in capital letters (e.g., AM)

Site Type: GPS or SPS.

Visit: Sequential visit identifier (e.g., A for first visit to site, B for second visit, C for third visit).

Surface Type: A-CC for asphalt-surfaced pavements and P-CC for PCC-surfaced pavements. Transverse profile measurements are not usually performed on PCC pavements.

Condition: Enter condition of pavement as either V.GOOD, GOOD, FAIR or POOR (use capital letters). Use the following guidelines to select condition:

> **V. GOOD**—Pavement does not show any distress.
>
> **GOOD**—Pavement exhibits few visible signs of surface deterioration. Pavement may show low severity cracks.
>
> **FAIR**—Typical distresses can include the following in a low to medium severity: rutting, transverse and longitudinal cracking, block cracking, fatigue, edge cracking, and patching.
>
> **POOR**—Typical distresses can include the following in a medium to high severity: rutting, transverse and longitudinal cracking, block cracking, fatigue cracking, patching, and potholes.

Road Name: Highway or route designation in capital letters (e.g., INTERSTATE 57, U.S. 395, S.R. 31).

Lane: Circle either “Outside” or “Inside.” The outside lane is the outermost traffic lane. Almost all LTPP sections are located in the outside lane. The inside lane is any lane that is not an outside lane.

Direction: Direction should be NORTH, EAST, WEST, or SOUTH (use capital letters).

Clouds: Valid entries for this field are CLEAR, P. CLOUDY, or CLOUDY (use capital letters). Use the following guidelines to select an appropriate entry to this field:

> **CLEAR**—Sunny sky.
>
> **P. CLOUDY**—Sun is sometimes covered by clouds.
>
> **CLOUDY**—Sun cannot be observed.

Temperature: Pavement temperature in Centigrade obtained using an infrared device.

Weather Comment: Any additional comments about the weather conditions at the time of testing. ProQual contains the following predetermined comments, but the crew is not limited to the use of these comments exclusively: CONDITIONS OK, STEADY CROSSWIND, WIND GUSTS, HOT AND HUMID, HAZY, LOW SUN ANGLE. Use capital letters for weather comment.

C.3.5.3 Transverse Profile Measurement

Collect Dipstick transverse profile measurements at 15.24 m intervals, starting at station 0+00. Measure elevations for each transverse profile location from the outside pavement edge extend over the full lane width, with the actual distance depending on lane width and pavement striping. The starting point should be the junction of the transverse measurement line and the inside edge of the white paint stripe along the outside edge of the lane. If no outside edge stripe is present, or if the outside edge stripe is on the shoulder, then begin at either the shoulder-lane joint or a point approximately 0.91 m from center of the outside wheel path. Enter a comment in the data sheet describing how the starting point was determined. The starting point on subsequent surveys should be the same. The initial elevation is arbitrarily established as "zero," and subsequent readings are recorded relative to this benchmark. The combination of these measurements provide a measure of pavement cross slope.

To begin transverse profile measurements, place the Dipstick at the outside edge of the pavement, beginning at Station 0+00 with the "start" arrow pointed toward the pavement centerline. Record measurements on the Transverse Profile Data Collection Form (DS-8). Complete two runs per transverse profile of each LTPP section; one run up the transverse line and a return along same line to complete a closed-loop survey.

After the last transverse profile measurement is completed, enter any additional comments on the last line of the form. The comment should be entered in capital letters (e.g., NINE DATA POINTS DUE TO HEAVY TRAFFIC).

C.3.5.4 Post-data Collection Check

After completing the survey, the operator must conduct zero and calibration checks. For the manual Dipstick (Model 1500), obtain readings R1 and R2 as described in "zero check" in section C.3.3.1. Readings from two placements (R1 and R2) should add up to within + 0.1 mm to pass the zero check. If the sum of the two readings is outside this limit, the device has failed the zero check.

For the automated Dipstick (Model 2000), place the Dipstick on a smooth, clean, and stable location (the Dipstick carrying case or a flat board will suffice) where the instrument can be positioned properly. Draw circles around the two footpads, and note reading at the switch end of the instrument (R1). Then rotate the instrument 180° and place the two footpads in the circles that were drawn earlier. Note the reading at the switch end of the Dipstick (R2). The two readings (R1 and R2) should add up to within + 0.1 mm to pass the zero check. If the sum of the two readings is outside these limits, the device has failed the zero check.

Enter the results of these checks on form DS-7. Based on results from these checks, follow one of the applicable procedures presented below:

1. If Dipstick fails zero check, then discard data as suspect.
2. If Dipstick passes zero check but fails calibration check, discard data as suspect and contact manufacturer for repair, as discussed under "calibration check" in section C.3.3.1.
3. If Dipstick passes both tests, perform the closure error computations described in section C.3.5.4.

If Dipstick fails the zero check, but can be adjusted to pass the zero check and also passes the calibration check, perform another survey.

C.3.5.5 Closure Error Computation

The total accumulated error in a transverse profile is established by a closed-loop survey. The forward and return runs along a transverse line are used to compute this error. At each station, add the readings for the forward and return runs separately, and record the values in the "Sum" column of form DS-8. Then at each station, add the values in "Sum" column for the forward and return run, and record the result in the "Closure" column. At each station, for each Dipstick reading, add the reading for the forward and return runs, and record the value in the field "Difference."

To compute the allowable closure error for a transverse profile run, multiply the total number of Dipstick readings (sum of the number of readings for forward and return runs) by 0.076 (0.076 mm is the allowable average error per one Dipstick reading). The allowable closure error for typical lane widths that are encountered are given in table C1.

If the closure error for a transverse profile is outside the allowable range, discard those data and repeat the transverse profile measurement. The value in the "Difference" field at a specific position gives the difference in readings between the forward and return runs at that position. The operator can use this information to identify locations where problem readings may be occurring.

TABLE C1. Allowable Closure Errors for Transverse Dipstick Measurements

LANE WIDTH (M)	TOTAL NUMBER OF DIPSTICK READINGS	ALLOWABLE CLOSURE ERROR (MM)
3.05	20	+/-1.5
3.35	22	+/-1.7
3.66	24	+/-1.8
3.96	26	+/-2.0

If after several repeat runs at a station(s), a closure error within allowable value is not obtained, and Dipstick passes post-data collection checks, describe why the closure error is outside the allowable value (e.g., ROUGH SURFACE TEXTURE MADE CLOSURE DIFFICULT).

C.3.6 Data Backup

The importance of safeguarding Dipstick data cannot be overstated. Backup copies of the Dipstick data must be made without exception, after completing data collection. Make a minimum of two complete copies of all Dipstick data. Mail one copy to the RSC office, and keep the second copy in case the first copy is lost in the mail.

C.4 CALIBRATION

C.4.1 General Background

To ensure that the Dipstick is operating properly, perform the zero and calibration checks described in section C.3.3.1. If the Dipstick fails the calibration check, return it to the manufacturer for repair.

The RSC should ensure that the gauge block used for the calibration check is calibrated annually to an accuracy of 3.18 + 0.03 mm using a local calibration laboratory or a calibration micrometer. Gauge block calibration may need to be performed more frequently, depending on (1) presence of oxidation, (2) evidence of erosion, and (3) possible damage caused by accidental mishandling in field. If the calibration block is not within an accuracy of 3.18 + 0.03 mm, a new block that satisfies the criteria should be obtained.

If calibration block (gauge block) thickness is not within 3.18 + 0.03 mm, all data collected since last block check are suspect and may have to be disregarded.

C.4.2 Calibration Frequency

The operator should conduct zero and calibration checks before and after any Dipstick measurements. Procedures for performing pre-operational zero and calibration checks are described in section C.3.3.1. Procedures for performing post-operational zero and calibration checks are described in section C.3.3.3. If the Dipstick fails calibration check, the RSC engineer must approve shipping the equipment to the manufacturer.

C.5 EQUIPMENT MAINTENANCE AND REPAIR

C.5.1. General Background

Scheduled preventive maintenance will ensure proper equipment operation and help identify potential problems. Timely identification of problems will help avoid costly delays or incomplete data that could result from onsite equipment malfunction. Time constraints on the profile testing program require that maintenance activities be performed before testing mobilization. During testing, the operator must be aware constantly of the proper functioning of the equipment. There will be little time to accomplish more than the required initial checks at site in preparation for the test day. Therefore, it is necessary to perform preventive maintenance routinely at the end of each test day.

Minimizing the equipment deterioration rate is the responsibility of the RSC and individual operators. Specific, detailed maintenance procedures are contained in the manuals provided with each individual piece of equipment, and the operator must become intimately familiar with the maintenance recommendations contained in these manuals. This section reinforces the concept of maximum equipment dependability, which is critical to the LTPP program's effectiveness.

This guide does not supersede the manufacturer's minimum services and service intervals, but rather provides supplementary service requirements. Where there is a conflict between this guide and the manufacturer's instructions, follow the more stringent requirements.

C.5.2 Routine Maintenance

Routine maintenance includes those functions that can be performed easily by the operator with minimal device disassembly. Routine maintenance for the Dipstick includes cleaning and lubrication of ball and socket joints on footpads, replacing batteries, and cleaning battery contacts. These items are basic and easily performed preventive measures, and always should be completed before and after equipment operation.

The following list of pre- and post-operation preventive maintenance items is not complete, but is intended to show the extent and detail required before operation checks are performed. This list of items does not supersede the manufacturer's minimum requirements for warranty compliance.

1. **Exterior:** Check general appearance, glass display (should be clean), ball and socket joint for footpads (should be lubricated properly).
2. **Accessories:** Be sure adequate supplies of consumables are available (e.g., batteries, WD-40).

C.5.3 Scheduled Major Maintenance

Scheduled major preventive services include much more than routine checks and will require some equipment disassembly by personnel with technical capabilities beyond the skill of operators or RSC staff. The operator should use the LTPP Major Maintenance/Repair Report (DS-10) to report performance of necessary services. This form will also inform the RSC of the Dipstick's condition on a regular basis. Items such as battery connector replacement fall into the major maintenance category. Appropriate service intervals are outlined in the equipment manufacturer's manual.

C.5.4 Equipment Problems/Repairs

Regardless of the quality of the preventive program, there probably will be equipment failures during the LTPP program. When these occur, it is extremely important that items are repaired or replaced quickly. During periods when there is no scheduled testing, these problems are handled easily. However, if they occur during mobilization or while onsite, significant problems in scheduling and coordination could develop. To help minimize the impact of equipment problems, it is essential that the operator immediately notify the RSC and any other agencies or individuals as necessary.

Each RSC is responsible for equipment maintenance/repair activity. However, the RSC should keep LTPP staff informed of any major problems concerning equipment. When repairs are necessary and must be performed by an outside agency, the operator should report this information on the LTPP Major Maintenance Report as an unscheduled maintenance activity. Details of circumstances during field testing related to this maintenance activity should be noted on appropriate data sheets.

C.6 RECORD KEEPING

The Dipstick operator is responsible for maintaining the following forms/records:

1. For Longitudinal Profile Measurements: Longitudinal Profile Forms DS-1 through DS-6.
2. For Transverse Profile Measurements: Dipstick Data Collection Form—Transverse Profile, form DS-8.
3. Zero and Calibration Check Records (form DS-7) for both longitudinal and transverse profile measurements.
4. Major Maintenance/Repair Report, form DS-10.

All these forms are included at the end of this appendix. Each of these records should be kept in up-to-date files by each RSC with one complete set kept on file at the regional office. A description of each of these forms follows.

C.6.1 Longitudinal Profile Measurements (DS-1 through DS-6)

Complete forms DS-1 through DS-6 at every section/project where longitudinal profile measurements are performed with a Dipstick. The "comments" section in these forms should include any downtime and any factors that might affect collected test data. Names and organizations of other personnel present at the site should be included in this form. Names of these personnel will be invaluable if an accident occurs at the test site. The operator should keep the form originals and forward copies to the RSC.

C.6.2 Zero and Calibration Check (DS-7)

Complete form DS-7 whenever the zero and calibration checks are conducted.

C.6.3 Transverse Profile Measurements (DS-8)

Complete form DS-8 at every section where transverse profile measurements are performed with a Dipstick. Follow the guidelines presented in section C.3.5.2 to complete the header fields in this form. The operator should keep the original form and forward a copy to the RSC.

C.6.4 LTPP Major Maintenance/Repair Report (DS-10)

Complete form DS-10 whenever an outside agency performs any major maintenance or repair.

Data Collection Forms

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-1 Measurement Information and Closure Computation	State Code [__ __] LTPP Section [__ __ __ __] Date (dd/mmm/yy) __ __ / __ __ __ / __ __

Operator: ______________________ Employer: ______________________

Recorder: ______________________ Employer: ______________________

Dipstick Serial Number: ______________

Start Time (military): __ __ : __ __ Stop Time (military): __ __ : __ __

Weather: ____

Closure Error Computation

Right Wheel Path		Left Wheel Path		
No	Elevation Sum	No	Elevation Sum	
O1		I1		
O2		I2		
O3		I3		**Traffic Control Crew:**
O4		I4		
O5		I5		
O6		I6		
O7		I7		
O8		I8		
O9		I9		
O10		I10		
O11		I11		
O12		I12		
O13		I13		**Other Personnel At Site:**
O14		I14		
O15		I15		
O16		I16		
O17		I17		
O18		I18		
O19		I19		
O20		I20		
Total O1 to O20	OA	Total I1 to I20	IA	
Transverse Sum T2	OB	Transverse Sum T1	IB	**Closure Error**
Total OA+OB	OC	Total IA + IB	IC	OC+IC

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-2 Reading 1 to 100	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm.)	
	RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑
1			26			51			76		
2			27			52			77		
3			28			53			78		
4			29			54			79		
5			30			55			80		
6			31			56			81		
7			32			57			82		
8			33			58			83		
9			34			59			84		
10			35			60			85		
11			36			61			86		
12			37			62			87		
13			38			63			88		
14			39			64			89		
15			40			65			90		
16			41			66			91		
17			42			67			92		
18			43			68			93		
19			44			69			94		
20			45			70			95		
21			46			71			96		
22			47			72			97		
23			48			73			98		
24			49			74			99		
25			50			75			100		
Sum	O1	I1		O2	I2		O3	I3		O4	I4

Transverse Closure Measurements from Left Wheel Path to Right Wheel Path at Station 0+00

	Transverse Position							Sum
	LWP-1	1-2	2-3	3-4	4-5	5 - CC	CC - RWP	
Reading (mm)								T1

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-3 Reading 101 to 200	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)	
	RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑
101			126			151			176		
102			127			152			177		
103			128			153			178		
104			129			154			179		
105			130			155			180		
106			131			156			181		
107			132			157			182		
108			133			158			183		
109			134			159			184		
110			135			160			185		
111			136			161			186		
112			137			162			187		
113			138			163			188		
114			139			164			189		
115			140			165			190		
116			141			166			191		
117			142			167			192		
118			143			168			193		
119			144			169			194		
120			145			170			195		
121			146			171			196		
122			147			172			197		
123			148			173			198		
124			149			174			199		
125			150			175			200		
Sum	O5	I5		O6	I6		O7	I7		O8	I8

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-4 Readings 201 to 300	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)	
	RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑
201			226			251			276		
202			227			252			277		
203			228			253			278		
204			229			254			279		
205			230			255			280		
206			231			256			281		
207			232			257			282		
208			233			258			283		
209			234			259			284		
210			235			260			285		
211			236			261			286		
212			237			262			287		
213			238			263			288		
214			239			264			289		
215			240			265			290		
216			241			266			291		
217			242			267			292		
218			243			268			293		
219			244			269			294		
220			245			270			295		
221			246			271			296		
222			247			272			297		
223			248			273			298		
224			249			274			299		
225			250			275			300		
Sum	O9	I9		O10	I10		O11	I11		O12	I12

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-5 Readings 301 to 400	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)		Reading No.	Reading (mm)	
	RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑
301			326			351			376		
302			327			352			377		
303			328			353			378		
304			329			354			379		
305			330			355			380		
306			331			356			381		
307			332			357			382		
308			333			358			383		
309			334			359			384		
310			335			360			385		
311			336			361			386		
312			337			362			387		
313			338			363			388		
314			339			364			389		
315			340			365			390		
316			341			366			391		
317			342			367			392		
318			343			368			393		
319			344			369			394		
320			345			370			395		
321			346			371			396		
322			347			372			397		
323			348			373			398		
324			349			374			399		
325			350			375			400		
Sum	O13	I13		O14	I14		O15	I15		O16	I16

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-6 Station 401 to 500	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)		Reading No	Reading (mm)	
	RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑		RWP⇓	LWP⇑
401			426			451			476		
402			427			452			477		
403			428			453			478		
404			429			454			479		
405			430			455			480		
406			431			456			481		
407			432			457			482		
408			433			458			483		
409			434			459			484		
410			435			460			485		
411			436			461			486		
412			437			462			487		
413			438			463			488		
414			439			464			489		
415			440			465			490		
416			441			466			491		
417			442			467			492		
418			443			468			493		
419			444			469			494		
420			445			470			495		
421			446			471			496		
422			447			472			497		
423			448			473			498		
424			449			474			499		
425			450			475			500		
Sum	O17	I17		O18	I18		O19	I19		O20	I20

Transverse Closure Measurements from Right Wheel Path to Left Wheel Path at Station (152.40 m)

	Transverse Position							Sum
	RWP-1	1-2	2-3	3-4	4-5	5 - CC	CC -LWP	
Reading (mm)								T2

LTPP Dipstick Data Collection Form Longitudinal Profile Form DS-7 Pre/Post Measurement Zero and Calibration Checks	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Operator: ______________________________ Employer: ______________________________

Dipstick Serial Number: ____________________ Diameter of Dipstick Foot Pad: __ . __ __ mm

Pre Measurement Checks

Time (military): __ __ : __ __ **Automated Dipstick** - Zero Check Performed: __________

Zero Check - Manual Dipstick		Calibration Check	
Measurement	Reading (mm)	Measurement	Reading (mm)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	A	Second Reading - 3.2 - First Reading	B

Notes:

A. First + Second Reading must be less than ±0.1. If not, adjust the start pin as suggested in the LTPP Profile Measurement Manual and repeat zero check.

B. Second Reading - 3.2 - First Reading must be less than ±0.1. If not, notify the RSC office and contact Face Company for repair.

Post Measurement Checks

Time (military): __ __ : __ __

Zero Check		Calibration Check	
Measurement	Reading (mm)	Measurement	Reading (mm)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	A	Second Reading - 3.2 - First Reading	B

Notes:

A. First + Second Reading must be less than ±0.1. If not, discard data as suspect, adjust the start pin as suggested in the LTPP Profile Measurement Manual, repeat zero check until it passes, perform calibration check and if it passes, resurvey section.

B. Second Reading - 3.2 - First Reading must be less than ±0.1. If not, notify the RSC office and contact Face Company for repair.

Comments: ____

LTPP Dipstick® Data Collection Form
Transverse Profile
Form DS-8

Dipstick® Serial #: [___ ___ ___ ___ ___] Dipstick® Model #: [___ ___ ___ ___]
Operator: [___ ___] Recorder: [___ ___] Site Type: [___ ___ ___] Visit: [___ ___]
Surface Type: [___ - ___ ___] Condition: ______________________

State Code [___ ___]
LTPP Section ID [___ ___ ___ ___]
Date (dd/mmm/yy) ___ ___ / ___ ___ ___ / ___ ___
Time [___ ___ : ___ ___]

Road Name: ______________________ Lane: Outside / Inside (Circle One) Direction: [___ ___ ___ ___ ___]
Clouds: ____________ Temperature: [___ ___ . ___] Weather Comment: ______________________

Location	Dipstick® Readings 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Sum	Closure
0.00																		
Difference																		
15.24																		
Difference																		
30.48																		
Difference																		
45.72																		
Difference																		
60.96																		
Difference																		
76.20																		
Difference																		
91.44																		
Difference																		
106.68																		
Difference																		
121.92																		
Difference																		
137.16																		
Difference																		
152.40																		
Difference																		

COMMENTS: ______________________

LTPP Dipstick Operations
LTPP Major Maintenance/Repair Activity Report
Form DS-10

Region: ________________________________ **Date:** ______________________________

Make: Face Company **Model:** ____________________

Serial Number: ________________

Reason for Maintenance Work (Choose only one)

Scheduled: _________ **Not Scheduled:** _________

Description Of Maintenance And Reason: ____

____

____

____

____

Agency Performing Maintenance: **Cost:** _________________

Name: ____

Street: ____

City: _________________________________ **State:** __________ **Zip:** ___________

Number: ____

Contact Name: ____

Date In: ____

Date Out: ____

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

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