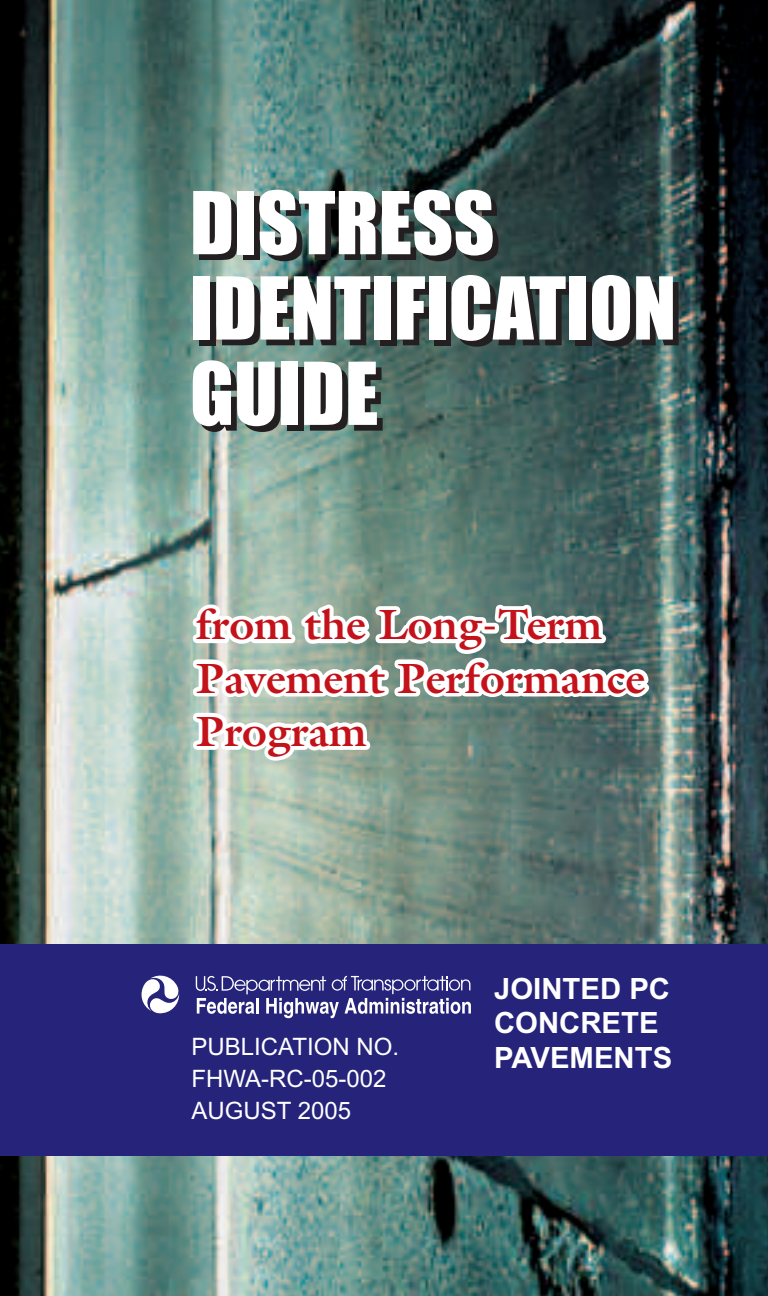

DISTRESS IDENTIFICATION GUIDE

from the Long-Term Pavement Performance Program

U.S. Department of Transportation
Federal Highway Administration

PUBLICATION NO.
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JOINTED PC CONCRETE PAVEMENTS

U.S. Department of Transportation
Federal Highway Administration

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This pocket guide is derived from the Long-Term Pavement Performance (LTPP) program's Distress Identification Manual, Fourth Revised Edition, Publication No. FHWA–RD–03–031, published in June 2003 as part of the Strategic Highway Research Program.

Additional copies of this pocket guide can be obtained by contacting the LTPP Product Development and Delivery Team at 410–962–5623 or by visiting the LTPP Products website at http://www.tfhrc.gov/pavement/ltpp/product.htm.

Recycled
Recyclables

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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U.S. Department of Transportation
Federal Highway Administration

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RESOURCE CENTER

DISTRESSES FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

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

B. Joint Deficiencies / 14
5. Joint Seal Damage
5a. Transverse Joint Seal Damage
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7. Spalling of Transverse Joints

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8a. Map Cracking
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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

This section covers jointed (plain and reinforced) Portland cement concrete-surface 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 2		
1. Corner Breaks	Numbers	Yes
2. Durability Cracking ("D" Cracking)	Number of Slabs, m^2 (ft^2)	Yes
3. Longitudinal Cracking	Meters (Feet)	Yes
4. Transverse Cracking	Number, m (ft)	Yes
B. Joint Deficiencies / page 14		
5a. Transverse Joint Seal Damage	Number	Yes
5b. Longitudinal Joint Seal Damage	Number, m (ft)	No
6. Spalling of Longitudinal Joints	Meters (Feet)	Yes
7. Spalling of Transverse Joints	Number, m (ft)	Yes
C. Surface Defects / page 24		
8a. Map Cracking	Number, m^2 (ft^2)	No
8b. Scaling	Number, m^2 (ft^2)	No
9. Polished Aggregate	m^2 (ft^2)	No
10. Popouts	Not Measured	N/A
D. Miscellaneous Distress / page 29		
11. Blowups	Number	No
12. Faulting of Transverse Joints & Cracks	mm (inches)	No
13. Lane-to-Shoulder Dropoff	mm (inches)	No
14. Lane-to-Shoulder Separation	mm (inches)	No
15. Patch/Patch Deterioration	Number, m^2 (ft^2)	Yes
16. Water Bleeding and Pumping	Number, m (ft)	No

A. Cracking: This section includes the following 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.

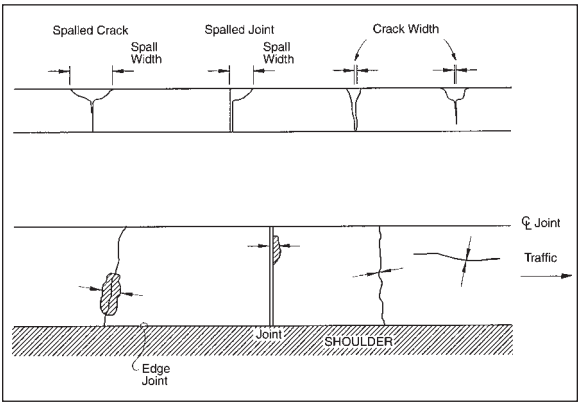

Figure 47: Measuring Widths of Spalls and Cracks in Jointed Concrete Pavement

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 (1.0 ft) 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 (0.5 in); 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 (0.5 in); 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.

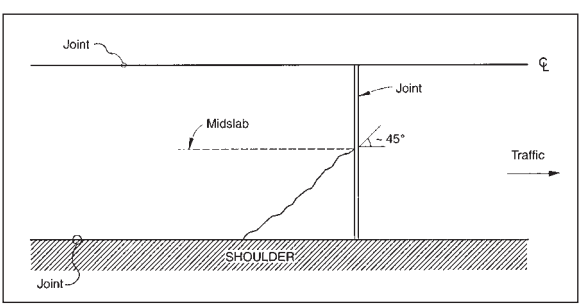

Figure 48: Distress Type JCP 1 – Corner Breaks

Figure 49: Distress Type JCP 1
Low Severity Corner Break

Figure 50: Distress Type JCP 1
Moderate Severity Corner Break

2. 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 (square feet) 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.

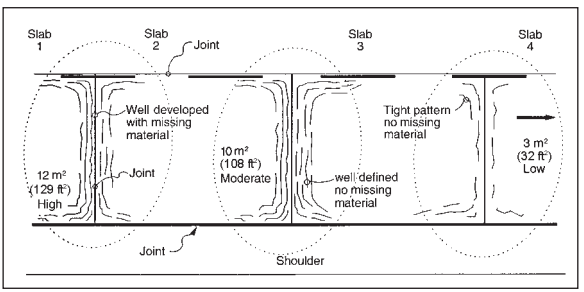

Figure 51: Distress Type JCP 2
Durability Cracking ("D" Cracking)

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 (1.0 ft^2), may have been patched.

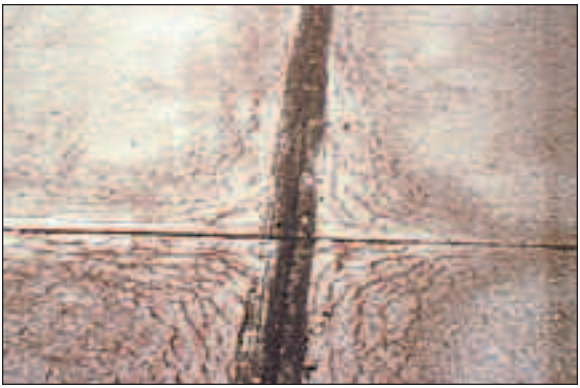

Figure 52: Distress Type JCP 2 – Moderate Severity "D" Cracking with Well-Defined Pattern

Figure 53: Distress Type JCP 2
High Severity "D" Cracking with Loose and Missing Material

3. LONGITUDINAL CRACKING

Description

Cracks that are predominantly parallel to the pavement centerline.

Severity Levels

LOW

Crack widths < 3 mm (0.1 in), no spalling and no measurable faulting; or well-sealed and with a width that cannot be determined.

MODERATE

Crack widths ≥ 3 mm (0.1 in) and < 13 mm (0.5 in); or with spalling < 75 mm (3 in); or faulting up to 13 mm (0.5 in).

HIGH

Crack widths ≥ 13 mm (0.5 in); or with spalling ≥ 75 mm (3 in); or faulting ≥ 13 mm (0.5 in).

How to Measure

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

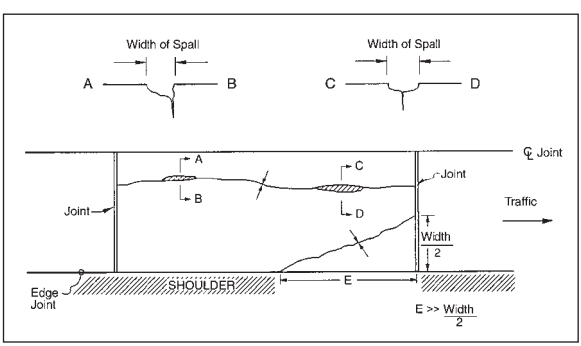

Figure 54: Distress Type JCP 3 – Longitudinal Cracking

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

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4. TRANSVERSE CRACKING

Description

Cracks that are predominantly perpendicular to the pavement centerline.

Severity Levels

LOW

Crack widths < 3 mm (0.1 in), no spalling and no measurable faulting; or well-sealed and the width cannot be determined.

MODERATE

Crack widths ≥ 3 mm (0.1 in) and < 6 mm (0.25 in); or with spalling < 75 mm (3 in); or faulting up to 6 mm (0.25 in).

HIGH

Crack widths ≥ 6 mm (0.25 in); or with spalling ≥ 75 mm (3 in); or faulting ≥ 6 mm (0.25 in).

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 (feet), 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 (feet), of transverse cracking at each severity level with sealant in good condition. The length recorded, in meters (feet), 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.

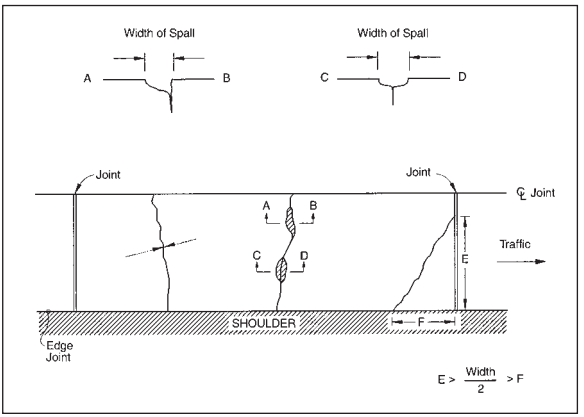

Figure 58: Distress Type JCP 4
Transverse Cracking

Figure 59: Distress Type JCP 4
Moderate Severity Transverse Cracking

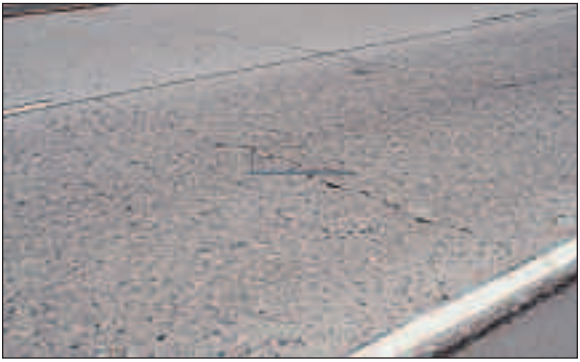

Figure 60: Distress Type JCP 4
High Severity Transverse Cracking

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

5. 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.

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 (3 ft) in length.

Figure 61: Distress Type JCP 5
Low Severity Joint Seal Damage

Figure 62: Distress Type JCP 5
Moderate Severity Joint Seal Damage

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6. SPALLING OF LONGITUDINAL JOINTS

Description

Cracking, breaking, chipping, or fraying of slab edges within 0.3 m (1 ft) from the face of the longitudinal joint.

Severity Levels

LOW

Spalls < 75 mm (3 in) 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 (3 in) to 150 mm (6 in) wide, measured to the face of the joint, with loss of material.

HIGH

Spalls > 150 mm (6 in) 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 (feet) of longitudinal joint affected at each severity level. Only record spalls that have a length of 0.1 m (0.3 ft) 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.

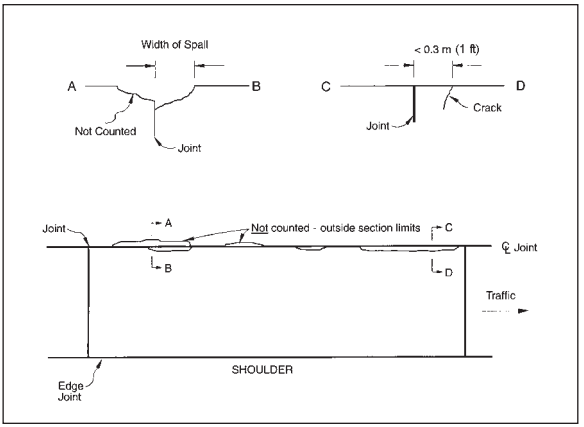

Figure 63: Distress Type JCP 6
Spalling of Longitudinal Joints

Figure 64: Distress Type JCP 6
Low Severity of Longitudinal Joint

Figure 65: Distress Type JCP 6
High Severity Spalling of Longitudinal Joint

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7. SPALLING OF TRANSVERSE JOINTS

Description

Cracking, breaking, chipping, or fraying of slab edges within 0.3 m (1 ft) from the face of the transverse joint.

Severity Levels

LOW

Spalls < 75 mm (3 in) 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 (3 in) to 150 mm (6 in) wide, measured to the face of the joint, with loss of material.

HIGH

Spalls > 150 mm (6 in) 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 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 (feet) of the spalled portion of the joint affected 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.

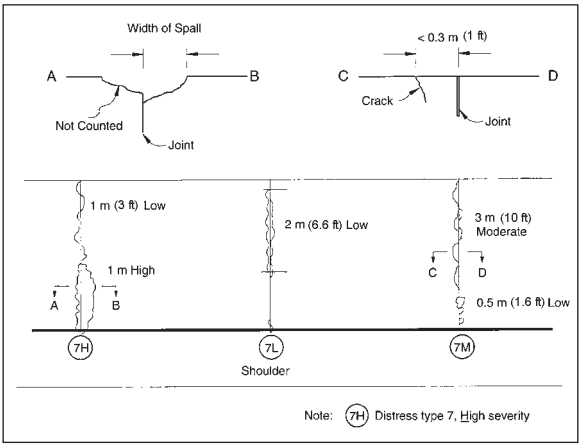

Figure 66: Distress Type JCP 7
Spalling of Transverse Joints

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

8. MAP CRACKING AND SCALING

8a. *MAP CRACKING*

Description

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

Severity Levels

Not Applicable

How to Measure

Record the number of occurrences and the square meters (square feet) 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 (0.1 in) to 13 mm (0.5 in), and may occur anywhere over the pavement.

Severity Levels

Not Applicable

How to Measure

Record the number of occurrences and the square meters (square feet) of affected area.

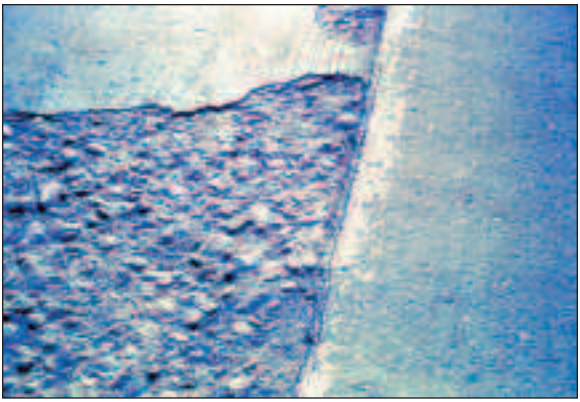

Figure 70: Distress type JCP 8b - Scaling

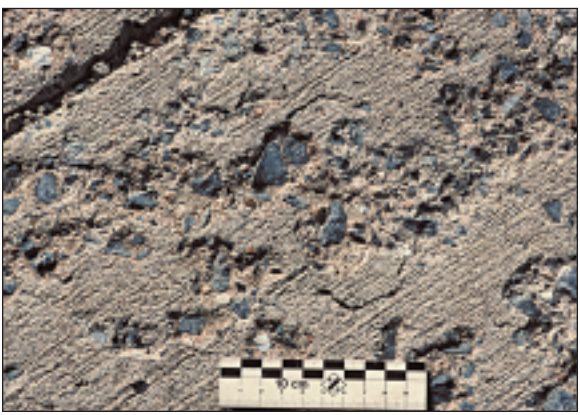

Figure 71: Distress type JCP 8b – Scaling Close-up View

9. 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 (square feet) 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.

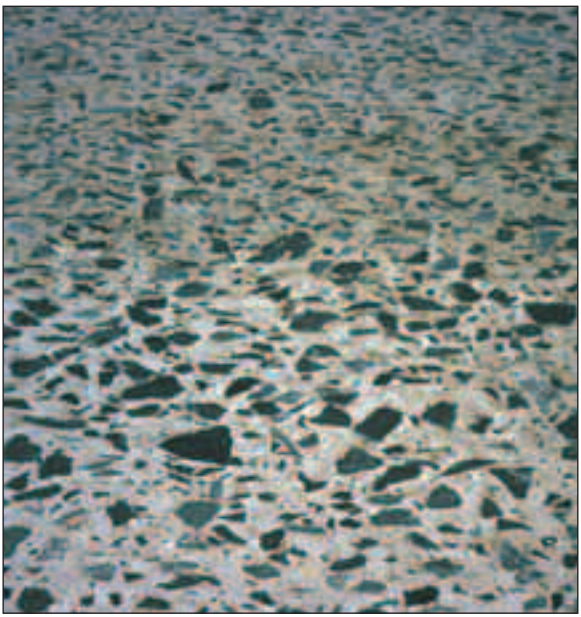

Figure 72: Distress Type JCP 9
Polished Aggregate

10. POPOUTS

Description

Small pieces of pavement broken loose from the surface, normally ranging in diameter from 25 mm (1 in) to 100 mm (4 in), and depth from 13 mm (0.5 in) to 50 mm (2 in).

Severity Levels

Not Applicable.

However, severity levels can be defined in relation to the intensity of popouts as measured below.

How to Measure

Not recorded in LTPP surveys.

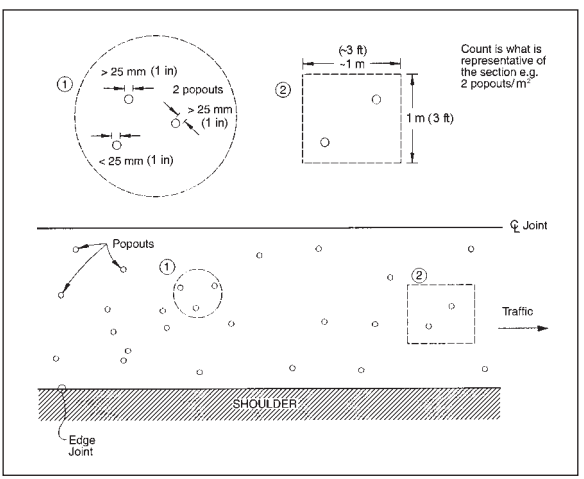

Figure 73: Distress Type JCP 10 – Popouts

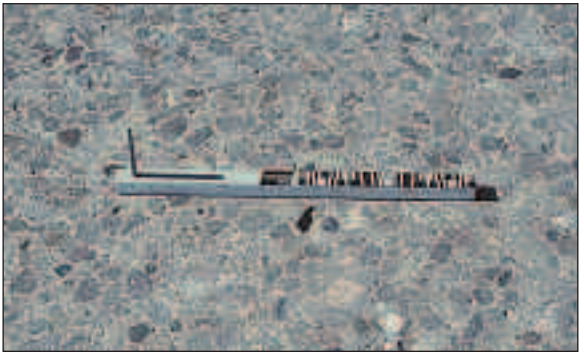

Figure 74: Distress Type JCP 10 - A Popout

D. Miscellaneous Distresses: This section includes the following distresses:

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

11. BLOWUPS

Description

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

Severity Levels

Not Applicable.

However, severity levels can be defined by the relative effect of a blowup on ride quality and safety.

How to Measure

Record the number of blowups.

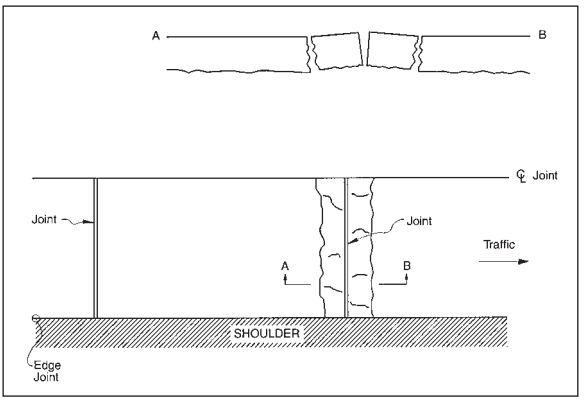

Figure 75: Distress Type JCP 11 – Blowups

Figure 76: Distress Type JCP 11 – A Blowup

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Description

Difference in elevation across a joint or crack.

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 (inches), to the nearest millimeter (inch): 0.3 m (1 ft) and 0.75 m (2.5 ft) from the outside slab edge (approximately the outer wheel path). For a widened lane, the wheel path location will be 0.75 m (2.5 ft) 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 that 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 (1 ft). 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.

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 (1.6 ft). evaluate newly observed distresses and point distance differences for previously identified distresses of 0.5 m (1.6 ft) and greater with a metric (English) tape measure.

Note: The precise start point of surveys must be clearly identified in the field.

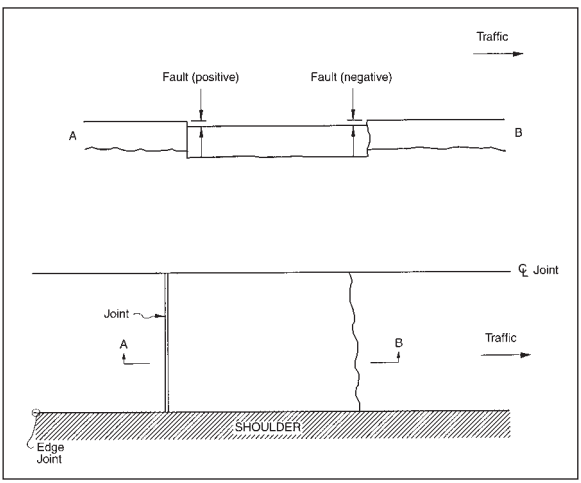

Figure 77: Distress Type JCP 12
Faulting of Transverse Joints and Cracks

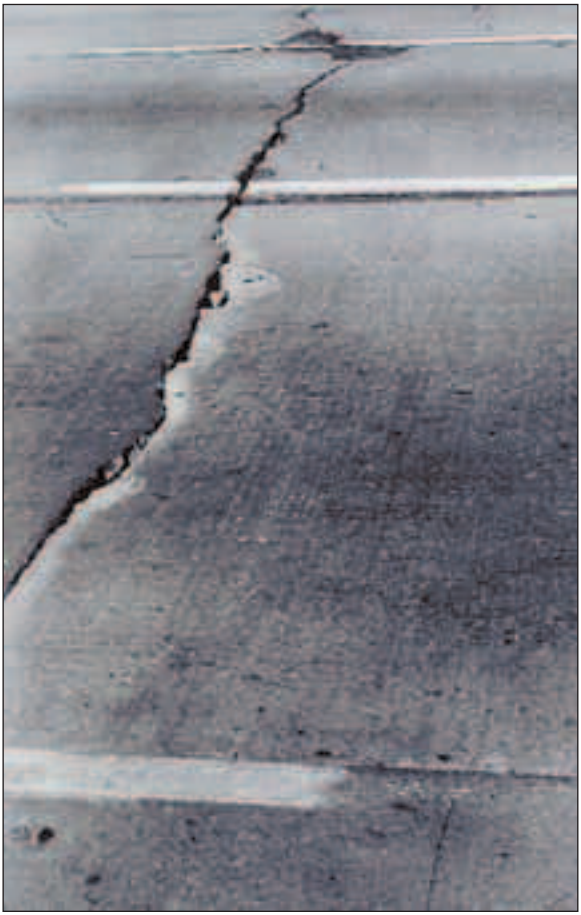

Figure 78: Distress Type JCP 12
Faulting of Transverse Joints and Cracks

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

Record Measure at the longitudinal construction point between the lane edge and the shoulder.

Record to the nearest millimeter (inch) at 15.25 m (50 ft) intervals along the lane-to-shoulder joint.

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

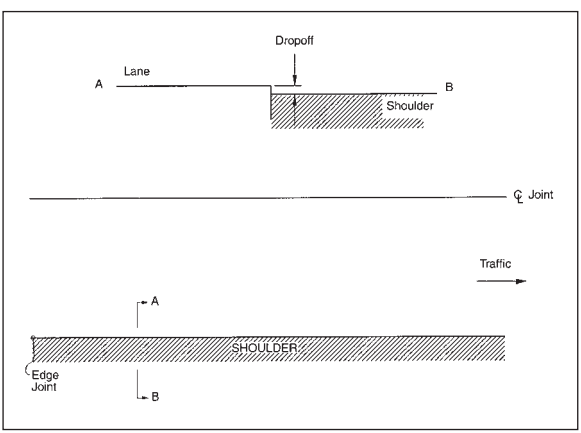

Figure 79: Distress Type JCP 13
Lane-To-Shoulder Dropoff

Figure 80: Distress Type JCP 13
Lane-To-Shoulder Dropoff

14. LANE-TO-SHOULDER SEPARATION

Description

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

Severity Levels

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

How to Measure

Record to the nearest millimeter (inch) at intervals of 15.25 m (50 ft) 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 able to take a measurement due to an anomaly such as sealant or patch material.

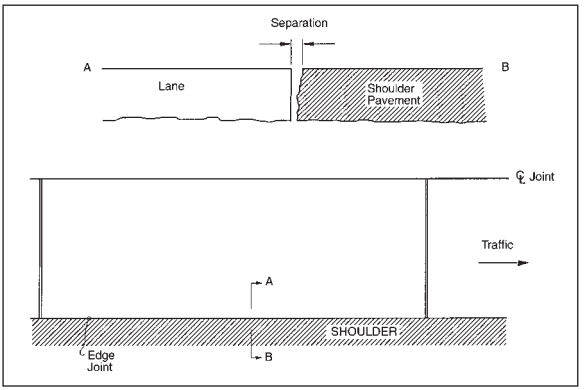

Figure 81: Distress Type JCP 14
Lane-To-Shoulder Separation

Figure 82: Distress Type JCP 14
Poorly Sealed Lane-To-Lane Separation

Figure 83: Distress Type JCP 14
Well Sealed Lane-To-Lane Separation

15. PATCH/PATCH DETERIORATION

Description

A portion, greater than 0.1 m^2 (1.0 ft^2), 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 6 mm (0.25 in); pumping is not evident.

HIGH

Patch has high severity distress of any type; or faulting or settlement ≥ 6 mm (0.25 in); pumping may be evident.

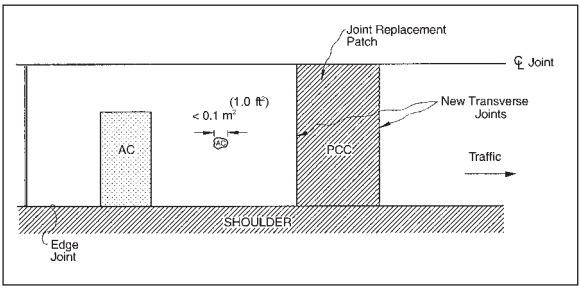

Figure 84: Distress Type JCP 15
Patch/Patch Deterioration

How to Measure

Record number of patches and square meters (square feet) 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.

Figure 85: Distress Type JCP 15
Small, Low Severity Asphalt Concrete Patch

Figure 86: Distress Type JCP 15
Large, Low Severity Asphalt Concrete Patch

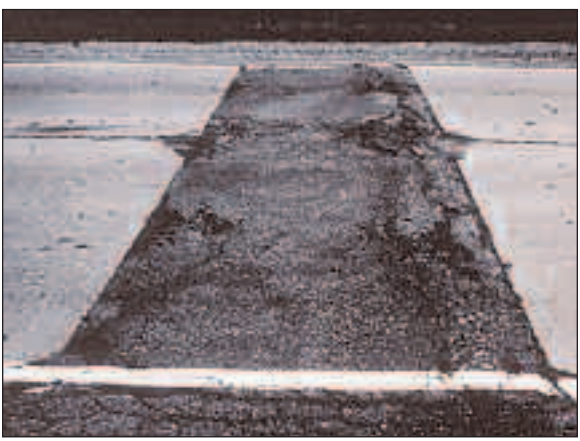

Figure 87: Distress Type JCP 15
Large, High Severity Asphalt Concrete Patch

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 (feet) of affected pavement with a minimum length of 1 m (3 ft).

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

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 that 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, inter-connecting 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 (0.1 in)

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 wheel paths

SCALING
the deterioration of the upper 3–12 mm (0.1 in–0.5 in) 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 (2 ft) 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

Appendix A

MANUAL FOR DISTRESS SURVEYS

Table of Contents

Introduction / A1

Equipment for Distress Surveys / A2

Instructions for Completing Distress Maps / A2
Jointed Portland Cement Concrete Pavement

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Instructions for Completing JCP Data Sheets / A5
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Description of Data Sheet 5
Description of Data Sheet 6
Description of Data Sheet 7

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Blank Distress Map Forms and Data Sheets / A15

INTRODUCTION

This appendix provides instructions, data sheets, and distress maps for use in visual surveys for the collection of distress information for JCP 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 (100 ft) long and a scale or ruler graduated in millimeters (0.04 in).
- 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 (50 ft) maps that represent 30.5 m (100 ft) of the test section, with the exception of SPS-6 sections 2 and 5, which are 305 m (1000 ft).

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. Figure A2 illustrates 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 (14 ft) of the slab measured from the centerline longitudinal joint to the shoulder joint.

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 (100 ft) subsection is mapped, the tape measure should be moved to map the second 30.5m (100 ft) subsection. The process is repeated throughout the test section.

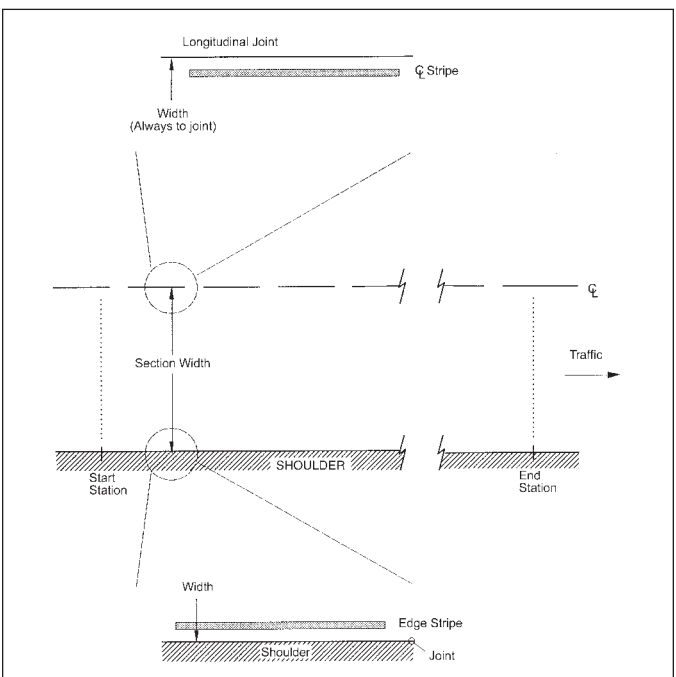


FIGURE A2:
Test Section Limits for Surveys—Concrete Surface

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 predominantly parallel to the centerline of a JCP would be labeled "3H."

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 A6 and A7. The specific distress types that are not to be included on the maps are to be recorded as follows:

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 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 of 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. 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 (1.0 ft) and 0.75 m (2.5 ft) from the outside edge of the slab.

For widened lanes, measure 0.3 m (1.0 ft) from the edge of the slab and 0.75 m (2.5 ft) 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 (0.001 feet).

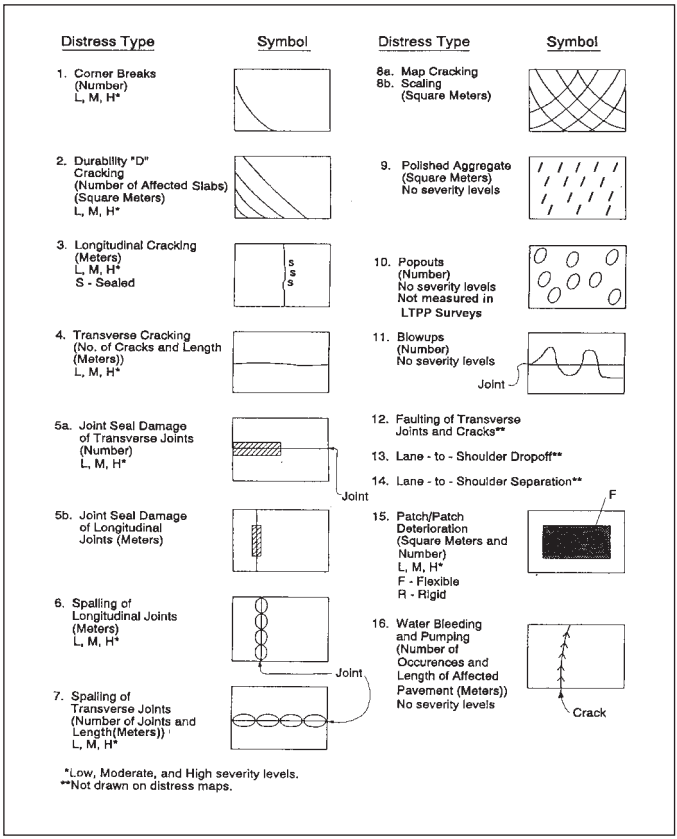


FIGURE A6:
Distress Map Symbols for Jointed Concrete Pavements

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.

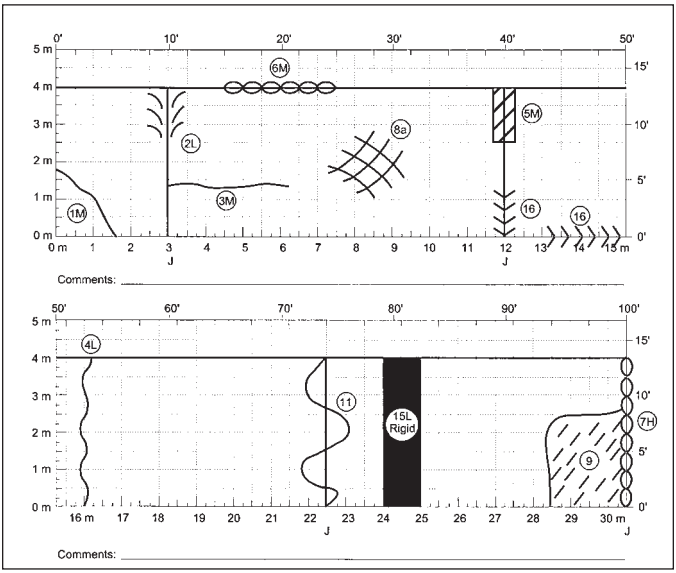


FIGURE A7:
Example Map of First 30.5 meters (100 feet) of a Jointed Concrete Pavement Section

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 (0.04 in), between the pavement surface and the adjacent shoulder surface. Measurements are taken at the beginning of the test section and at 15.25 m (50 ft) 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 (0.003 ft) between the outside lane and the adjacent

shoulder surface. Measurements are taken at the beginning of the test section and at 15.25 m (50 ft) 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.

Example Survey Map Forms and Completed Data Sheets

This part of the appendix shows completed maps and survey forms for a JCP 60 m (200 ft) 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.

Revised May 29, 1992

SHEET 4

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID 1234

STATE CODE 28

SHRP SECTION ID 0101

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

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

SURVEYORS: JSR, EJE, ___
PAVEMENT SURFACE TEMP - BEFORE ___10 °C; AFTER ___19 °C
PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) P

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	1	0	3
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	0	0	0
AREA AFFECTED (Square Meters)	0.0	0.0	0.0
3. LONGITUDINAL CRACKING (Meters)	4.8	9.2	0.0
Length Sealed (Meters)	0.0	0.0	0.0
4. TRANSVERSE CRACKING (Number of Cracks)	1	1	0
(Meters)	1.8	3.5	0.0
Length Sealed (Meters)	0.0	3.5	0.0
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)			4.0
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	0.0	0.0	0.0
7. SPALLING OF TRANSVERSE JOINTS Number of Affected Joints	0	0	0
Length Spalled (Meters)	0.0	0.0	0.0

Completed Data Sheet 4: JCP Distress Survey

Revised May 29, 1992: September 1998

SHEET 5

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE 28

SHRP SECTION ID 0101

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	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
8a. MAP CRACKING (Number) (Square Meters)			0.0
8b. SCALING (Number) (Square Meters)			3.0
9. POLISHED AGGREGATE (Square Meters)			0.0
10. POPOUTS Not Recorded			
MISCELLANEOUS DISTRESSES			
11. BLOWUPS (Number)			0
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 DETERIORATION Flexible (Number) (Square Meters)	0.0	0.0	0.0
Rigid (Number) (Square Meters)	7.0	31.2	0.0
16 WATER BLEEDING AND PUMPING (Number of occurrences)			2
Length Affected (Meters)			4.5
17. OTHER (Describe):			

Data Sheet 5: JCP Distress Survey

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.

Data Sheet 6: JCP Distress Survey

Revised May 29, 1992

STATE ASSIGNED ID 1 2 3 4

SHEET 7

DISTRESS SURVEY

STATE CODE 2 8

LTPP PROGRAM

SHRP SECTION ID 0 1 0 1

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 6/1 2/1 2

SURVEYORS: J S R, E S E

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

13. LANE-TO-SHOULDER DROPOFF

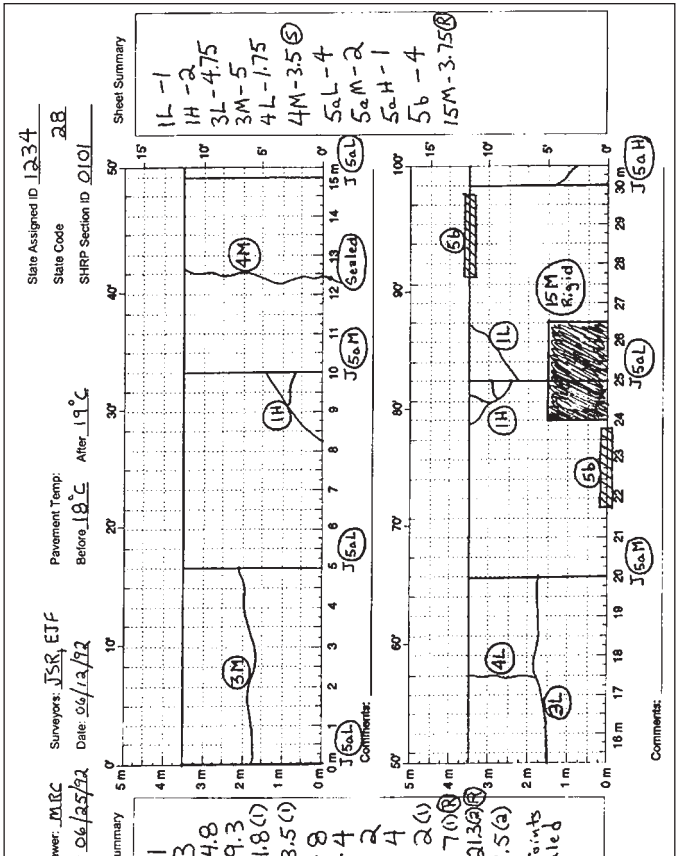
14. LANE-TO-SHOULDER SEPARATION

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	0.	10.	Y
4.	45.75	6.	8	Y
5.	61.			
6.	76.25			
7.	91.5	NOT MAPPED		
8.	106.75			
9.	122.			
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 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.

Data Sheet 7: JCP Distress Survey

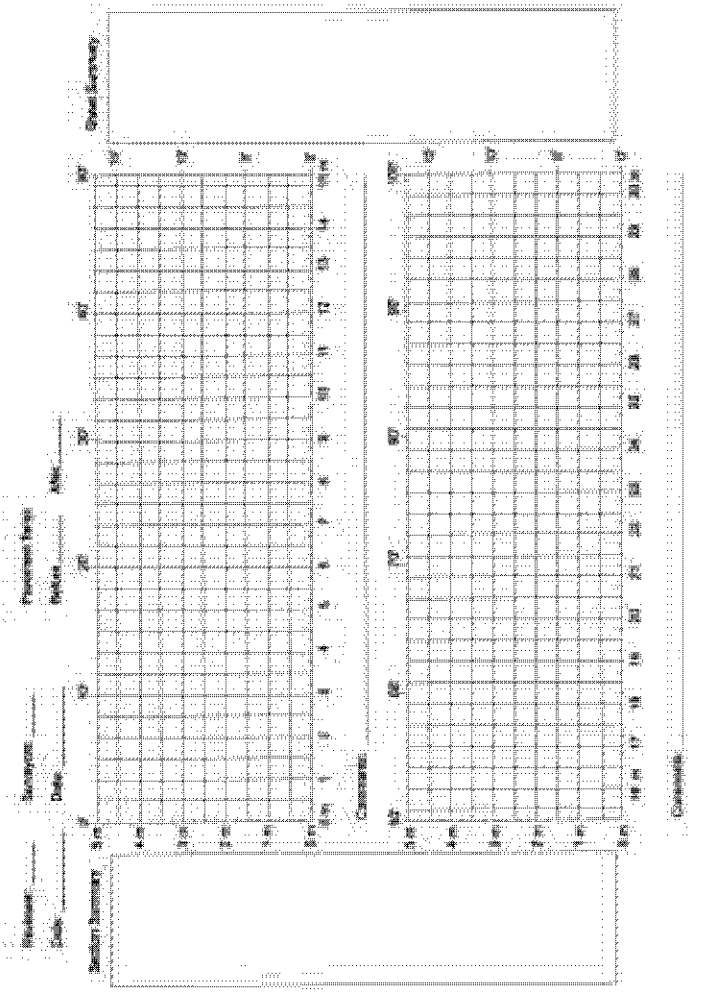


Completed Map Form: JCP Distress

Completed Map Form: JCP Distress

Blank Distress Map Forms and Data Sheets

These map forms and data sheets may be photocopied from the *Distress Identification Manual* for field use. Note that each type of pavement has its own data sheets.



Map Form: JCP Distress