DISTRESS IDENTIFICATION GUIDE

from the Long-Term Pavement Performance Program

ASPHALT CONCRETE PAVEMENTS

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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.

DISTRESSES FOR ASPHALT CONCRETE PAVEMENTS

This section covers asphalt concrete-surfaced pavements (ACP), ncluding ACP overlays on either asphalt concrete (AC) or portland ement concrete (PCC) pavements.

ach of the distresses has been grouped into one of the following ategories:

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 2		
1. Fatigue Cracking	m^2 (ft^2)	Yes
2. Block Cracking	m^2 (ft^2)	Yes
3. Edge Cracking	Meters (Feet)	Yes
4a. Wheel Path Longitudinal Cracking	Meters (Feet)	Yes
4b. Non-Wheel Path Longitudinal Cracking	Meters (Feet)	Yes
5. Reflection Cracking at Joints		
Transverse Reflection Cracking	Not Measured	N/A
Longitudinal Reflection Cracking	Not Measured	N/A
6. Transverse Cracking	Number, m (ft)	Yes
B. Patching and Potholes / page 21		
7. Patch/Patch Deterioration	Number, m^2 (ft^2)	Yes
8. Potholes	Number, m^2 (ft^2)	Yes
C. Surface Deformation / page 28		
9. Rutting	mm (inches)	No
10. Shoving	Number, m^2 (ft^2)	No
D. Surface Defects / page 33		
11. Bleeding	m^2 (ft^2)	No
12. Polished Aggregate	m^2 (ft^2)	No
13. Raveling	m^2 (ft^2)	No
E. Miscellaneous Distress / page 40		
14. Lane-to-Shoulder Dropoff	Not Measured	N/A
15. Water Bleeding	Number, m (ft)	No

A. Cracking: 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.

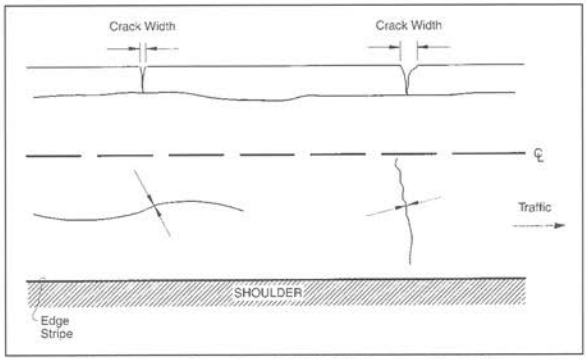


Figure 1: Measuring Crack Width in Asphalt Concrete Surfaced Pavements

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

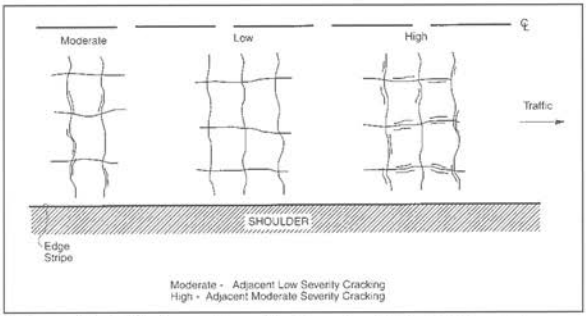


Figure 2: Effect on Severity Level of Block Cracking due to Associated Random Cracking

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 m (1 ft) 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.

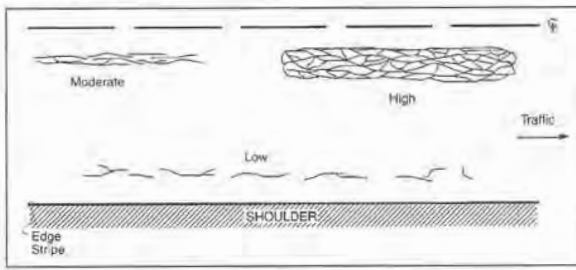


Figure 3: Distress Type ACP 1—Fatigue Cracking

How to Measure

Record square meters (square feet) 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 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

Rehabilitation Alternatives

If distress is localized:

Low Severity

Apply surface seal coat.

Rejuvenators may also be considered as an alternative. A rejuvenator could be used if it will aid in healing the surface and reducing the amount of water that can center the base.

Expected life of the treatment will range from less than a year to 5 years, depending on the structure and the section traffic.

Medium Severity

Partial Depth Patch
Full Depth Patch

High Severity:

Partial Depth Patch
Full Depth Patch

If distress is more wide spread:

All Severities

Structural Rehabilitation Including;

1. Overlay
2. Mill and Overlay
3. Recycling
4. Reconstruction

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 m^2 (1 ft^2) to 10 m^2 (100 ft^2).

Severity Levels

LOW

Cracks with a mean width ≤ 6 mm (0.25 in); 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 (0.25 in) and ≤ 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent low severity random cracking.

HIGH

Cracks with a mean width > 19 mm (0.75 in); or any crac. with a mean width ≤ 19 mm (0.75 in) and adjacent moderate to high severity random cracking.

How to Measure

Record square meters (square feet) of affected area at eacl 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 (50 ft) long before rating as block cracking.

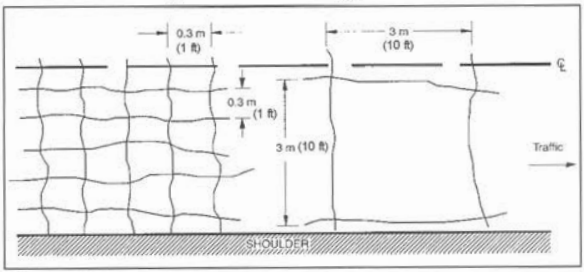


Figure 8: Distress Type ACP 2—Block Cracking

Rehabilitation Alternatives

Low Severity:

Do Nothing
Crack Seal
Apply Rejuvenator
Apply Seal Coat

Medium Severity:

Apply Seal Coat
Thin Overlay

High Severity:
Overlay
Recycle or Reconstruct

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

3. 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 (2 ft) of the pavement edge, adjacent to the shoulder. Includes longitudinal cracks outside of the wheel path and within 0.6 m (2 ft) 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 (feet) of pavement edge affected at each severity level. The combined quantity of edge cracking cannot exceed the length of the section.

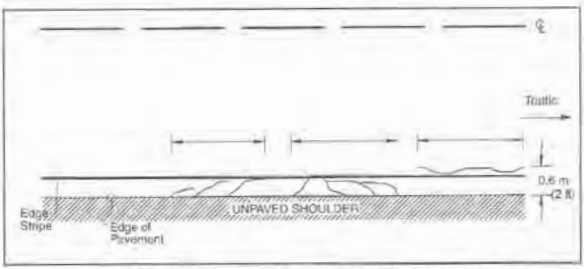


Figure 11: Distress Type ACP 3—Edge Cracking

Figure 12: Distress Type ACP 3
Low Severity Edge Cracking

Rehabilitation Alternatives

General

Improve shoulder drainage or seal shoulder from water; reconstruct edge and extend roadway width (if necessary).

Low Severity:

Do Nothing
Crack Seal

Medium Severity:

Crack Seal if Local
Partial Depth Patch
Full Depth Patch

High Severity:

Partial Depth Patch
Full Depth Patch

4. 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 (0.25 in); 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 (0.25 in) and ≤ 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent low severity random cracking.

HIGH

Any crack with a mean width > 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent moderate to high severity random cracking.

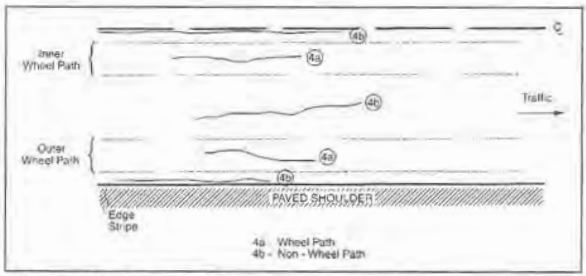


Figure 13: Distress Type ACP 4 Longitudinal Cracking

How to Measure Record separately:

4A. WHEEL PATH LONGITUDINAL CRACKING

Record the length in meters (feet) of longitudinal cracking within the defined wheel paths at each severity level. Record the length in meters (feet) 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 (feet) of longitudinal cracking not located in the defined wheel paths at each severity level. Record the length in meters (feet) 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

Rehabilitation Alternatives

Low Severity:

Do Nothing
Crack Seal or fill
Rout and Seal with an Approved Sealant

Medium Severity:

Crack Seal
Rout and Seal with an Approved Sealant
Partial Depth Patch
Full Depth Patch
Slope Stabilization

High Severity:

Partial Depth Patch
Full Depth Patch
Slope Stabilization

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 (0.25 in); 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 (0.25 in) and ≤ 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent low severity random cracking.

HIGH

Any crack with a mean width > 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent moderate to high severity random cracking.

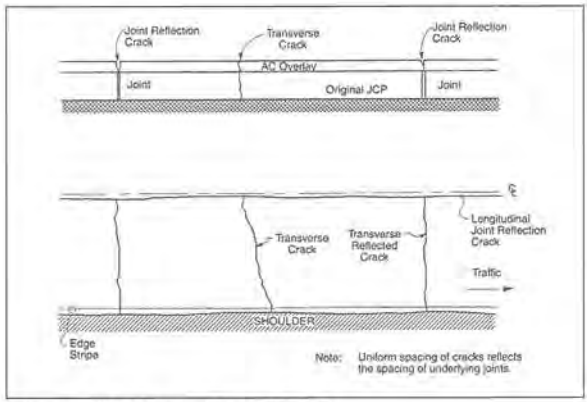


Figure 16: Distress Type ACP 5
Reflection Cracking at Joints

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

Rehabilitation Alternatives

Low Severity:

Do Nothing
Crack Seal or Rout and Seal with an Approved Sealant
If density is high, a seal coat will provide temporary protection.

Medium Severity:

Crack Seal
Rout and Seal with an Approved Sealant

High Severity:

Crack Seal
Rout and Seal with an Approved Sealant
Partial Depth Patch
If density is high, overlay, mill and overlay.
Reconstruction may be considered.

6. TRANSVERSE CRACKING

Description

Cracks that are predominantly perpendicular to pavement centerline.

Severity Levels

LOW

An unsealed crack with a mean width ≤ 6 mm (0.25 in); 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 (0.25 in) and ≤ 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent low severity random cracking.

HIGH

Any crack with a mean width > 19 mm (0.75 in); or any crack with a mean width ≤ 19 mm (0.75 in) and adjacent moderate to high severity random cracking.

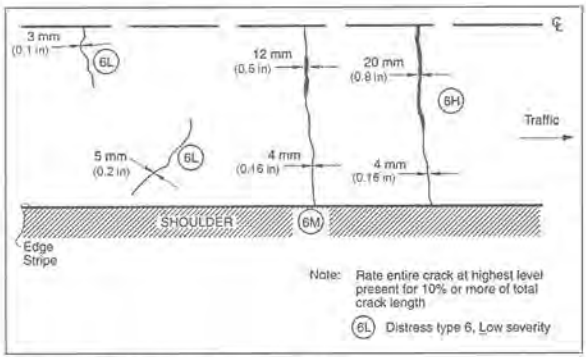


Figure 18: Distress Type ACP 6
Transverse Cracking Asphalt Concrete Surfaces

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 (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 length in meters (feet) 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 (1 ft) 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

Rehabilitation Alternatives

Low Severity:

Do Nothing
Crack Seal or Rout and Seal with an Approved Sealant
Apply a Surface Seal Emulsion
Apply an Aggregate Seal Coat

Medium Severity:

Crack Seal or Rout and Seal with an Approved Sealant
Apply an Aggregate Seal Coat

High Severity:

Partial Depth Patch
Apply an Aggregate Seal Coat

At some point, the frequency of cracks can be high enough that a more involved rehabilitation such as mil and overlay, reconstruct, :tc. will be more economical.

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, (1 ft^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 (0.25 in); pumping is not evident.

MODERATE

Patch has moderate severity distress of any type or rutting from 6 mm (0.25 in) to 12 mm (0.5 in); pumping is not evident.

HIGH

Patch has high severity distress of any type including ruttin > 12 mm (0.5 in), or the patch has additional different patch material within it; pumping may be evident.

How to Measure

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

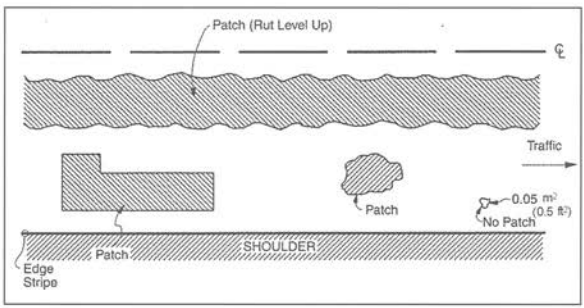


Figure 22: Distress Type ACP 7
Patch/Patch Deterioration

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

Rehabilitation Alternatives

Low Severity:

Do Nothing

Medium Severity:

Crack Seal
Partial Depth Patch
Full Depth Patch (Replace existing Patch)

High Severity:

Partial Depth Patch
Full Depth Patch (Replace existing Patch)

Subgrade deficiencies should be corrected before a new patch is placed.

8. POTHOLES

Description

Bowl-shaped holes of various sizes in the pavement surface Minimum plan dimension is 150 mm (0.5 ft).

Severity Levels

LOW

< 25 mm (1 in) deep.

MODERATE

25 mm (1 in) to 50 mm (2 in) deep.

HIGH

> 50 mm (2 in) deep.

How to Measure

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

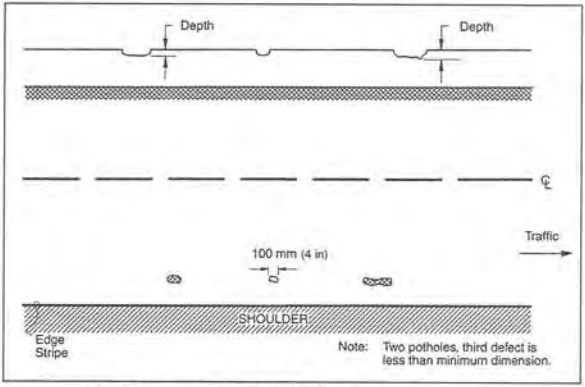


Figure 26: Distress Type ACP 8—Potholes

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

Rehabilitation Alternatives

Low Severity:

Partial Depth Patch
Full Depth Patch
Pothole Filling

Medium Severity:

Full Depth Patch
Pothole Filling

High Severity:

Full Depth Patch
Pothole Filling

If the overall condition of the road is such that reconstruction (not overlay) is planned, pothole patching may be done on a temporary basis. If the pavement is to be overlaid, a permanent patch should be placed.

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.

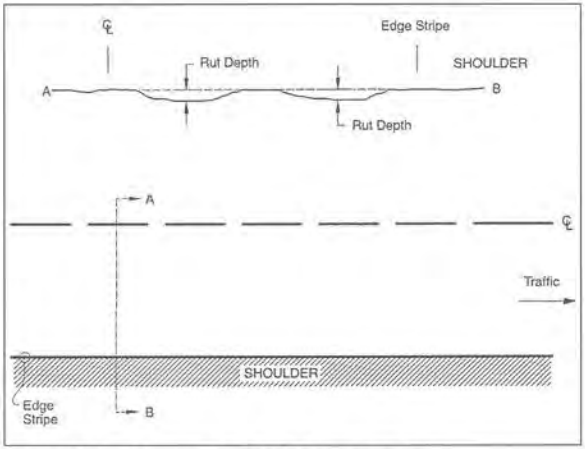


Figure 31: Distress Type ACP 9—Rutting

How to Measure

Specific Pavement Studies (SPS)-3 ONLY. Record maximum rut depth to the nearest millimeter (inches) at 15.25 m (50 ft) intervals for each wheel path, as measured with a 1.2 m (4 ft) straight edge.

All other LTPP sections: Transverse profile is measured with a Dipstick® profiler at 15.25 m (50 ft) intervals.

Figure 32: Distress Type ACP 9 - Rutting

Figure 33: Distress Type ACP 9
Standing Water in Ruts

Rehabilitation Alternatives

Low Severity:

Do Nothing
Partial Depth Patch
Skin Patch

Medium Severity:

Partial Depth Patch
Full Depth Patch
Skin Patch
Overlay
Mill and Overlay
Reconstruct

High Severity:

Partial Depth Patch
Full Depth Patch
Skin Patch
Overlay
Mill and Overlay
Reconstruct

When rutting occurs, the section should be fully evaluated to determine the exact cause. It is necessary to determine what layer is responsible. A mix stability problem may require removal and replacement. Base deformation may require removal and replacement if the cause is poor stability, or may require an overlay if the cause is consolidation of a poorly compacted base.

10. 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 (square feet) of affected surface area.

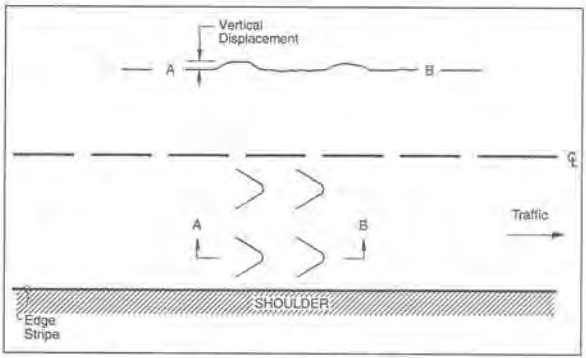


Figure 34: Distress Type ACP 10—Shoving

Figure 35: Distress Type ACP 10
Shoving in Pavement Surface

Rehabilitation Alternatives

Low Severity:
Do Nothing

Medium Severity:
Full Depth Patch

High Severity:
Full Depth Patch

D. Surface Defects: This section includes the following types of surface defects:

11. Bleeding
12. Polished Aggregate
13. Raveling

11. BLEEDING (FLUSHING)

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 exces. asphalt, to a condition where the aggregate may be obscure by excess asphalt possibly with a shiny, glass-like, reflective surface that may be tacky to the touch.

Severity Levels

LOW

An area of pavement surface discolored relative to the remainder of the pavement by excess asphalt.

MODERATE

An area of pavement surface that is losing surface texture due to excess asphalt.

HIGH

Excess asphalt gives the pavement surface a shiny appearance; the aggregate may be obscured by excess asphalt; tire marks may be evident in warm weather.

How to Measure

Record square meters (square feet) 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 Low Severity - Discoloration

Figure 37: Distress Type ACP 11
Moderate Severity - Loss of Texture

Figure 38: Distress Type ACP 11
High Severity - Aggregate Obscured

Rehabilitation Alternatives

Low Severity:

Do Nothing
Apply Heat and Roll Sand

Medium Severity:

Apply Heat and Roll Sand

High Severity:

Mill Overlay
Apply Aggregate Seal Coat
Apply Heat and Roll Sand

Bleeding (Flushing) is not easily corrected. It may be possible to use infra-red heating units to soften the asphalt and blot the excess material with sand. An overlay or seal coat may not solve the problem if there is sufficient asphalt remaining in the existing layers that continue to pump up to the surface. Also, it should be noted that the problem layer, or layer with the excess asphalt, does not have to be the wearing course; it could be the binder or base course.

12. 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 (square feet) 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.

Rehabilitation Alternatives

Do Nothing
Resurface with Seal Coat
Overlay

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

LOW

The aggregate or binder has begun to wear away but has not progressed significantly. Some loss of fine aggregate.

MODERATE

Aggregate and/or binder has worn away and the surface texture is becoming rough and pitted; loose particles generally exist; loss of fine aggregate and some loss of coarse aggregate.

HIGH

Aggregate and/or binder has worn away and the surface texture is very rough and pitted; loss of coarse aggregate.

How to Measure

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

Figure 40: Distress Type ACP 13
Low Severity - Loss of Fine Aggregate

Figure 41: Distress Type ACP 13 – Moderate Severity
Loss of Fine and Some Coarse Aggregate

Figure 42: Distress Type ACP 13
Loss of Coarse Aggregate

Rehabilitation Alternatives

Low Severity:

Do Nothing
Apply a Surface Seal Emulsion
Apply Rejuvenation

Medium Severity:

Apply a Surface Seal Emulsion
Apply an Aggregate Seal Coat

High Severity:

Partial Depth Patch (if it is localized)
Apply an Aggregate Seal Coat
Thin Overlay

Surface texture will dictate whether a seal coat can be used or an overlay is required. If the course aggregate is protruding over 12 mm (0.5 in), a seal coat may not be able to cover the pavement adequately.

E. Miscellaneous Distress: 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.

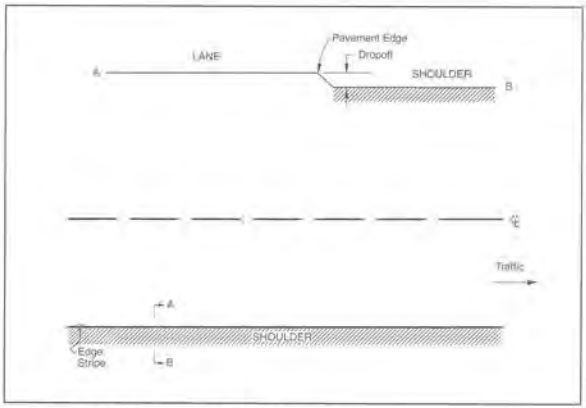


Figure 43: Distress Type ACP 14
Lane-to-Shoulder Dropoff

How to Measure

Not recorded in LTPP surveys.

Figure 44: Distress Type ACP 14 Lane-to-Shoulder Dropoff

Rehabilitation Alternatives

Low Severity:

Do Nothing

Medium Severity:

Do Nothing

Level Off Shoulder to Pavement Surface

High Severity:

Level Off Shoulder to Pavement Surface

On aggregate shoulders, leveling is accomplished by periodic blading. Paved shoulders can be leveled with a wedge overlay using a fine mix.

15. 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 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

Rehabilitation Alternatives

Crack Sealing or Repair (Rout and Seal with an Approved Sealant)
Joint Sealing or Repair
Undersealing
Improve Drainage (Edge Drains, etc.)

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 materi-' 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 pav ment

CORNER BREAK
a portion of a jointed concrete pave ment separated from the slab by a diagonal crack intersecting the tran. verse 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 calle "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

This appendix provides instructions, data sheets, and distress maps for use in visual surveys for the collection of distress information for ACP 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 A1 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. The ateral extent of AC test sections with double yellow lines on the nterline are determined by using the inside yellow line.

o map the test section, place the tape measure on the shoulder djacent to the test section from Station 0+00 to Station 1+00. It may oe necessary to secure the tape onto the pavement with adhesive tape r a heavy object. After the tape is in place, the distresses can be napped with the longitudinal placement of the distresses read from the tape. The transverse placement and extent of the distresses can e 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 30.5 m (100 ft) subsection. The process is repeated hroughout the test section.

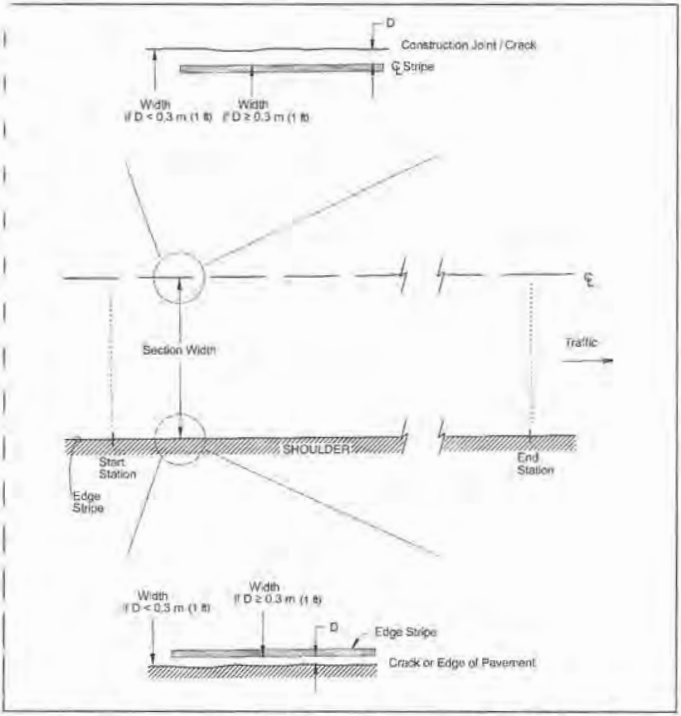


Figure A1: Test Section Limits for Surveys—Asphalt Surface

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 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 occurs 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.

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 [square feet] or number of occurrences) and are then recorded on sheets 1-3. It is important to carefully evaluate the distress map for certain distress types which have multiple

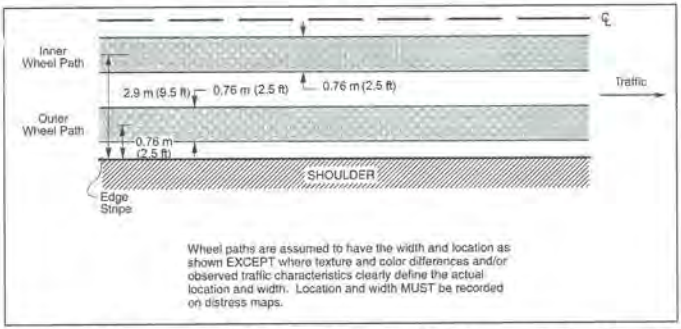


Figure A3: Locating Wheel Paths in Asphalt Concrete-Surfaced Pavements

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.

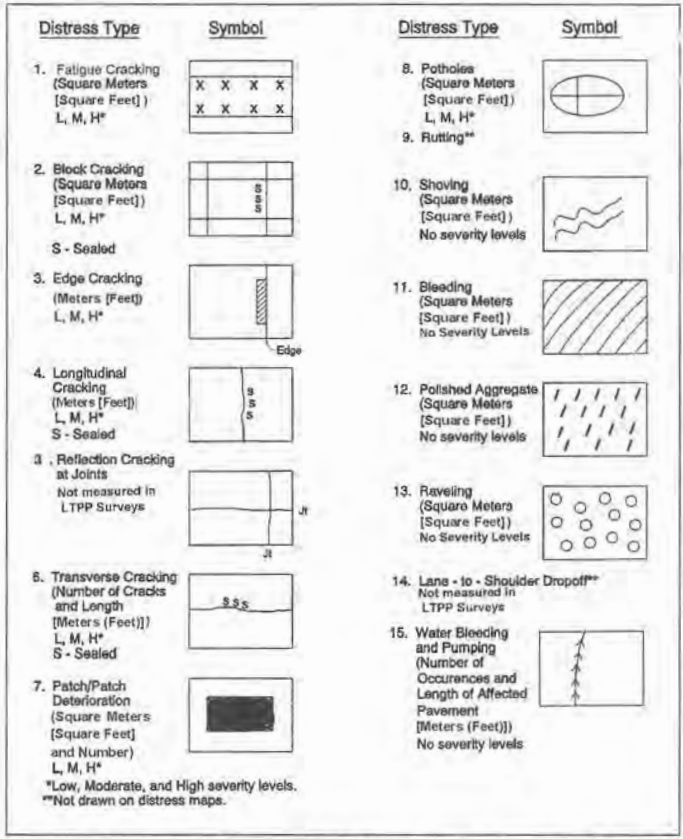


Figure A4: Distress Map Symbols for Asphalt Concrete-Surfaced Pavements

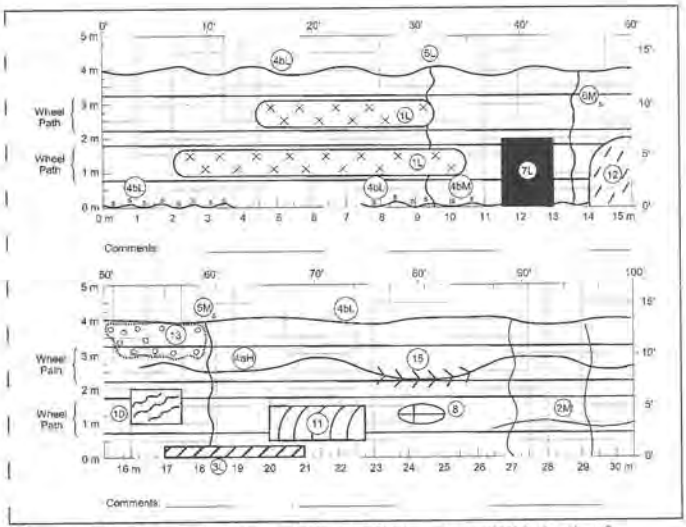


Figure A5: Example Map of First 30.5 meters (100 feet) of Asphalt Concrete Pavement Section

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 (4.0 ft) 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 (50 ft) intervals. There should be a total of 11 measurements in each wheel path, for a total of 22 measurements on each test section.

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.

Revised Dec 1992; Jan 1999; Feb 2002

SHEET 1

DISTRESS SURVEY — STATE CODE __ __

LTPP PROGRAM — 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 __ __ __ __ IC; AFTER __ __ __ __ IC

DISTRESS TYPE	SEVERITY LEVEL 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)	__ __ __.__	__ __ __.__	__ __ __.__

Data Sheet 1: ACP Distress Survey

Revised April 23, 1993; September 1998; June 1999

SHEET 2

DISTRESS SURVEY — STATE CODE __ __

LTPP PROGRAM — 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)			

Data Sheet 2: ACP Distress Survey

Revised May 29, 1992: September 1998

SHEET 3 STATE CODE __ __

DISTRESS SURVEY SHRP ID __ __ __ __

LTPP PROGRAM

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

SURVEYORS: __ __ __'__ __ __

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

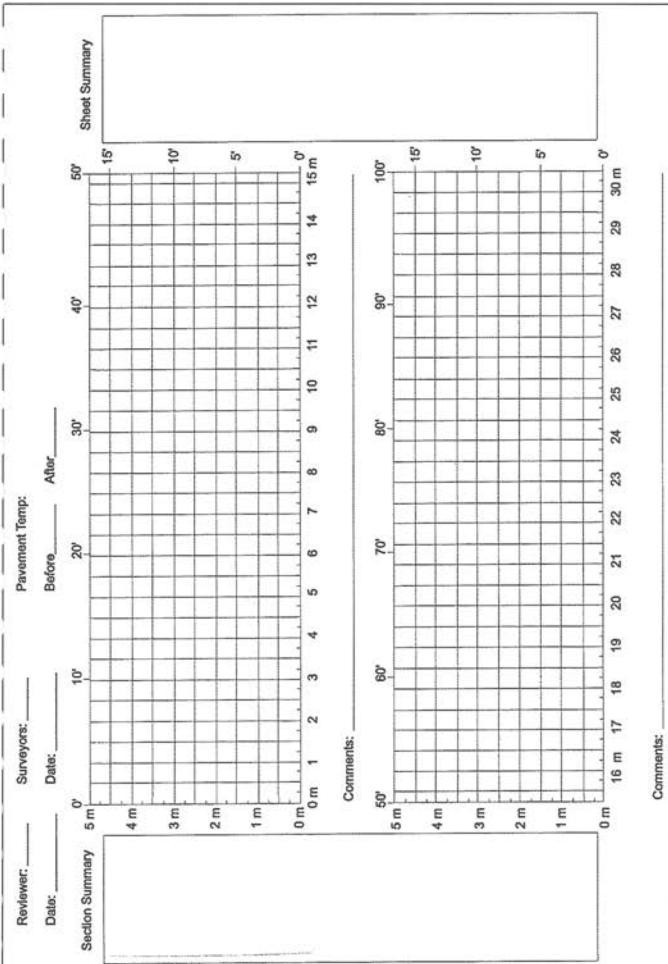
9. RUTTING (FOR SPS-3 SURVEYS)

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 SI equivalents of the 50 ft spacing used in previous surveys.

Data Sheet 3: ACP Distress Survey



Map Form: ACP Distress

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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Local Technical Assistance Program