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Distress Identification Manual for the Long-Term Pavement Performance Studies



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The publication of this manual does not necessarily indicate approval or endorsement of the findings, opinions, conclusions, or recommendations either inferred or specifically expressed herein by the National Academy of Sciences, the United States Government, or the American Association of State Highway and Transportation Official or its member states.

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A pavement distress identification manual was initially developed for use in the Long-Term Pavement Performance (LTPP), Asphalt Characteristics, Maintenance Cost-Effectiveness, and Cement and Concrete Studies being conducted under SHRP. The original manual was produced by Kurt D. Smith, Michael I. Darter, and Kathleen T. Hall of ERES Consultants, Inc., Champaign, Illinois, and J. Brent Rauhut of Brent Rauhut Engineering, Austin, Texas. Support for that work was provided by the Federal Highway Administration under Contract No. DTFH61-85-C-0095 as part of a "transition plan" to support development of planning for LTPP implementation pending SHRP funding by Congress.

This revised version was developed by Karen Benson of Texas Research and Development Foundation (TRDF), Austin, Texas, and Humberto Castedo and Dimitrios G. Goulias of the University of Texas at Austin, Center for Transportation Research (CTR), with guidance and support from W. R. Hudson of the University of Texas. Support for the revision work was provided by SHRP as part of Contract SHRP-87-P001.

The manual was developed to provide a uniform basis for collection of distress data during the long-term monitoring of the performance of pavement sections currently under study by SHRP.

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Contents

Acknowledgments	iii
List of Figures	viii
List of Tables	ix
Executive Summary	1
Distress for Pavements with Asphalt Concrete Surfaces	2
Cracking	4
Alligator (Fatigue) Cracking	5
Block Cracking	6
Edge Cracking	7
Longitudinal Cracking	8
Reflection Cracking at Joints	9
Transverse Cracking	10
Patching and Potholes	11
Patch/Patch Deterioration	12
Potholes	13
Surface Deformation	14
Rutting	15
Shoving	16
Surface Defects	17
Bleeding	18
Polished Aggregate	19
Raveling and Weathering	20
Miscellaneous Distresses	21
Lane-to-Shoulder Dropoff	22
Lane-to-Shoulder Separation	23
Water Bleeding and Pumping	24

Distresses For Pavements with Jointed Portland Cement Concrete Surfaces	25
Cracking	27
Corner Breaks	28
Durability “D” Cracking	29
Longitudinal Cracking	30
Transverse Cracking	31
Joint Deficiencies	32
Joint Seal Damage of Transverse Joints	33
Spalling of Longitudinal Joints	34
Spalling of Transverse Joints	35
Surface Defects	36
Map Cracking and Scaling	37
Polished Aggregate	38
Popouts	39
Miscellaneous Distresses	40
Blowups	41
Faulting of Transverse Joints and Cracks	42
Lane-to-Shoulder Dropoff	43
Lane-to-Shoulder Separation	44
Patch/Patch Deterioration	45
Water Bleeding and Pumping	46
Distresses for Pavements with Continuously Reinforced Portland Cement Concrete Surfaces	47
Cracking	49
Durability “D” Cracking	50
Longitudinal Cracking	51
Transverse Cracking	52
Surface Defects	53
Map Cracking and Scaling	54
Polished Aggregate	55
Popouts	56
Miscellaneous Distresses	57
Blowups	58
Construction Joint Deterioration	59
Lane-to-Shoulder Dropoff	60
Lane-to-Shoulder Separation	61

Patch/Patch Deterioration	62
Punchouts	63
Spalling of Longitudinal Joints	64
Water Bleeding and Pumping	65
Glossary	66
Index	69
Bibliography	70
Appendix	71

List of Figures

Figure 1: Cracking of Asphalt Concrete Pavement	4
Figure 2: Patching and Pothole of Asphalt Concrete Pavement.....	11
Figure 3: Surface Deformation of Asphalt Concrete Pavement	14
Figure 4: Surface Defects of Asphalt Concrete Pavement	17
Figure 5: Miscellaneous Distresses of Asphalt Concrete Pavement	21
Figure 6: Cracking of Jointed Concrete Pavement.....	27
Figure 7: Joint Deficiencies of Jointed Concrete Pavement	32
Figure 8: Surface Defects of Jointed Concrete Pavement.....	36
Figure 9: Miscellaneous Distresses of Jointed Concrete Pavement.....	40
Figure 10: Cracking of Continuously Reinforced Concrete Pavement	49
Figure 11: Surface Defects of Continuously Reinforced Concrete Pavement	53
Figure 12: Miscellaneous Defects of Continuously Reinforced Concrete Pavement.....	57

List of Tables

Table 1: Asphalt Concrete Surfaced Pavement Distress Types 3

Table 2: Jointed Concrete Surfaced Pavement Distress Types 26

Table 3: Continuously Reinforced Concrete Surfaced Pavement Distress Types 48

Executive Summary

This Distress Identification Manual was developed to provide a uniform basis for collection of distress data during long-term performance monitoring of in-service pavement sections by the Strategic Highway Research Program (SHRP) Long-Term Pavement Performance (LTPP) Program. In general, pavement distress surveys are taken within single traffic lane test sections, 500 feet in length. It is expected that the distress identification herein will be adopted by highway agencies in this country and abroad, so that the resulting data bases will offer broad opportunities for consistent evaluation and understanding of pavement performance.

Three basic pavement types are included: (1) asphalt concrete-surfaced; (2) jointed (plain and reinforced) concrete; and (3) continuously reinforced concrete. Each distress type is described, along with the associated severity levels and methods of measurement. In addition, photographs of typical distress conditions are provided to aid in identifying distress and quantifying its severity.

SHRP has developed data sheets and instructions for use as part of the pavement distress data collection process. Forms and instructions are included in SHRP's document, "Data Collection Guide For Long-Term Pavement Performance Studies," (Operational Guide No. SHRP-LTPP-OG-001, January 17, 1990). These data sheets were used in conjunction with the SHRP pavement distress data collection procedures. Changes may be made to meet individual user needs, for example, modification of section ID format, distress measurement units.

The Appendix includes a "**State Participation Synopsis**" describing a SHRP-developed Information Management System. It references software to store and retrieve pavement distress survey data. Also included are information on the selection criteria and components, as well as resources and a contact for additional information on the system.

1

Distresses for Pavements with Asphalt Concrete Surfaces

This section covers asphalt concrete (AC) surfaced pavements, including AC overlays of either asphalt concrete or portland cement concrete pavements. Each of the distresses have been categorized under one of the following general modes:

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

Table 1 presents a summary of distresses, severity levels, and units of measurement.

Table 1. Asphalt concrete surfaced pavement distress types.

<i>Distress Type</i>	<i>Units Measurements</i>	<i>Defined Severity Levels</i>
<i>Cracking</i>		
1. Alligator (Fatigue) Cracking	Square Feet	Yes
2. Block Cracking	Square Feet	Yes
3. Edge Cracking	Linear Feet	Yes
4. Longitudinal Cracking	Linear Feet	Yes
5. Reflection Cracking at Joints	No., Ln. Ft.	Yes
6. Transverse Cracking	No., Ln. Ft.	Yes
<i>Patching and Potholes</i>		
7. Patch/Patch Deterioration	Square Feet, Number	Yes
8. Potholes	Number	Yes
<i>Surface Deformation</i>		
9. Rutting	Inches	No
10. Shoving	No., Sq. Ft.	No
<i>Surface Defects</i>		
11. Bleeding	Square Feet	Yes
12. Polished Aggregate	Square Feet	No
13. Raveling and Weathering	Square Feet	Yes
<i>Miscellaneous Distress</i>		
14. Lane-to-Shoulder Dropoff	Inches	No
15. Lane-to-Shoulder Separation	Linear Feet	Yes
16. Water Bleeding and Pumping	No., Ln. Ft.	Yes

A. CRACKING

This section includes the following types of cracking:

1. Alligator (Fatigue) Cracking
2. Block Cracking
3. Edge Cracking
4. Longitudinal Cracking
5. Reflection Cracking at Joints
6. Transverse Cracking

The general form of the various types of cracking is illustrated in Figure 1.

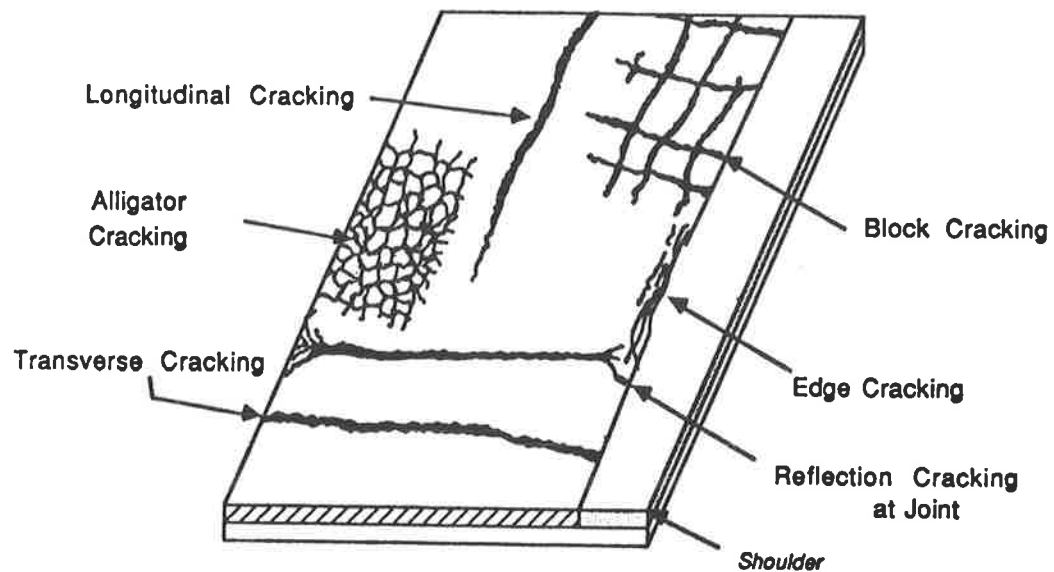


Figure 1. Cracking of asphalt concrete pavement

1. Alligator (Fatigue) Cracking

Description

- Series of interconnected cracks.
- Many-sided, sharp-angled pieces, usually less than 1' on longest side.
- Chicken wire/alligator pattern.
- Occurs only in areas subjected to repeated traffic loadings (usually in wheelpaths).
- Initially appears as longitudinal cracks.

Severity Levels

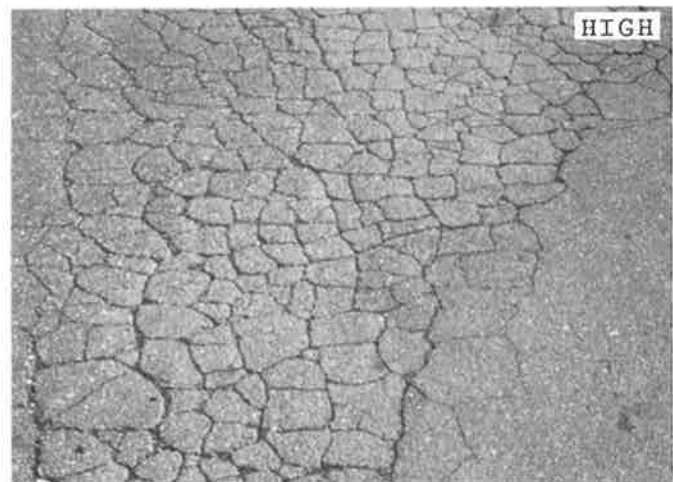
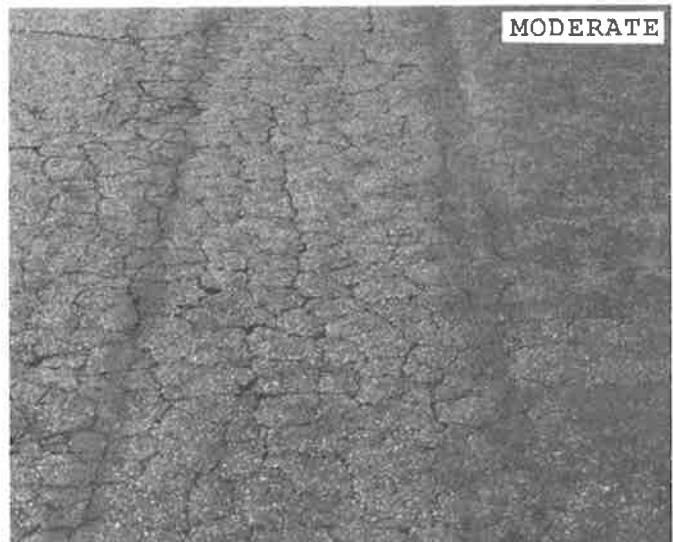
Low - Longitudinal disconnected hairline cracks running parallel to each other; may be a single crack in wheelpath; cracks not spalled.

Moderate - A pattern of articulated pieces formed by cracks that may be lightly spalled; cracks may be sealed.

High - Pieces more severely spalled at edges and loosened until the pieces rock under traffic; pumping may exist.

How to Measure

- Square feet of surface area at each severity level.
- If different severity levels existing within an area cannot be distinguished, rate entire area at highest severity present.



ASPHALT CONCRETE PAVEMENTS

2. Block Cracking

Description

Rectangular pieces of asphalt surface ranging in size from approximately 1 sq. ft. to 100 sq. ft.

Severity Levels

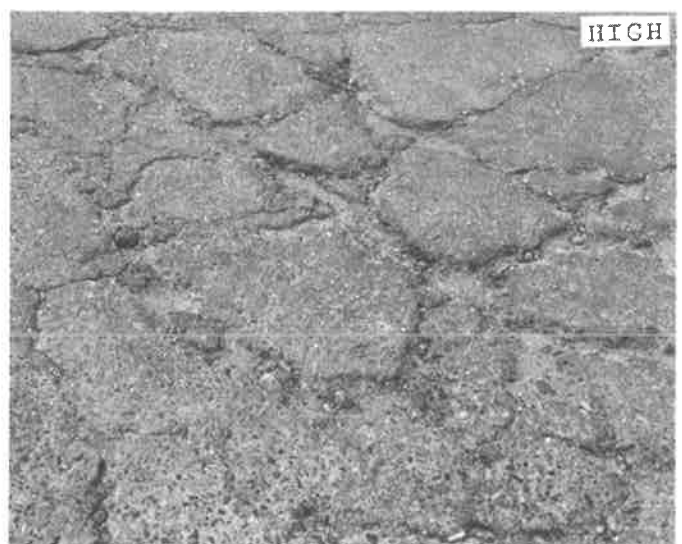
Low - Blocks defined by unspalled cracks with a mean width of 1/4" or less; cracks with sealant in good condition.

Moderate - Blocks defined by cracks that are moderately spalled; cracks with a mean width greater than 1/4".

High - Blocks well defined by cracks that are severely spalled.

How to Measure

Square feet of surface area at each severity level.



3. Edge Cracking

Description

- Crescent-shaped cracks or fairly continuous cracks, parallel to, and usually within 1' to 2' of, the outer edge of pavement.
- Occur when paved shoulders do not exist.

Severity Levels

Low - Cracks with no breakup or raveling.

Moderate - Cracks with some breakup or raveling.

High - Cracks with considerable breakup or raveling along edge.

How to Measure

Linear feet at each severity level.



ASPHALT CONCRETE PAVEMENTS

4. Longitudinal Cracking

Description

Cracks relatively parallel to pavement centerline.

Severity Levels

Low - Cracks with low severity or no spalling; mean unsealed crack width of 1/4" or less; sealant material in good condition.

Moderate - Cracks with moderately severe spalling; mean unsealed crack width of greater than 1/4"; sealant material in bad condition; low severity random cracking near the crack.

High - Cracks with high severity spalling; moderate or high severity random cracking near the crack.

How to Measure

Linear feet at each severity level.



5. Reflection Cracking at Joints

Description

- Cracks in asphalt concrete (AC) overlay surfaces over jointed concrete pavements at original joints.
- Knowing slab dimensions beneath AC surface helps identify these cracks.

Severity Levels

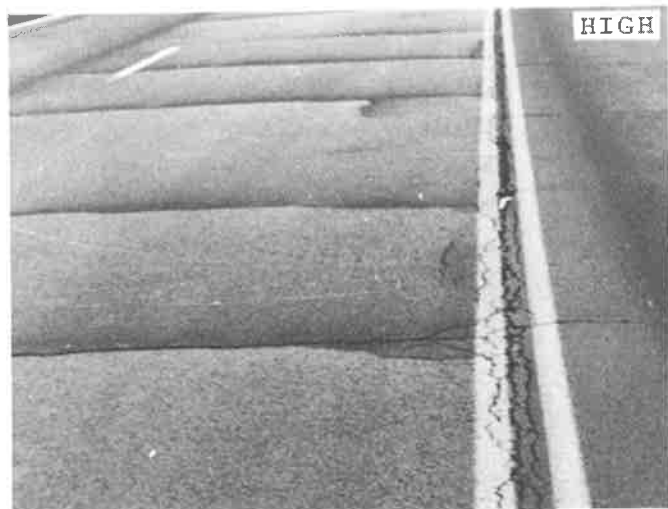
Low - Cracks with low severity or no spalling; mean unsealed crack width of 1/4" or less; sealant material in good condition.

Moderate - Cracks with moderate severity spalling; mean unsealed crack width of greater than 1/4"; sealant material in bad condition; low severity random cracking near the crack.

High - Cracks with high severity spalling; moderate or high severity random cracking near the crack.

How to Measure

- Number and linear feet of longitudinal and transverse cracks at each severity level.
- Measurements for longitudinal and transverse cracks shall be recorded separately.



6. Transverse Cracking

Description

Cracks relatively perpendicular to pavement centerline.

Severity Levels

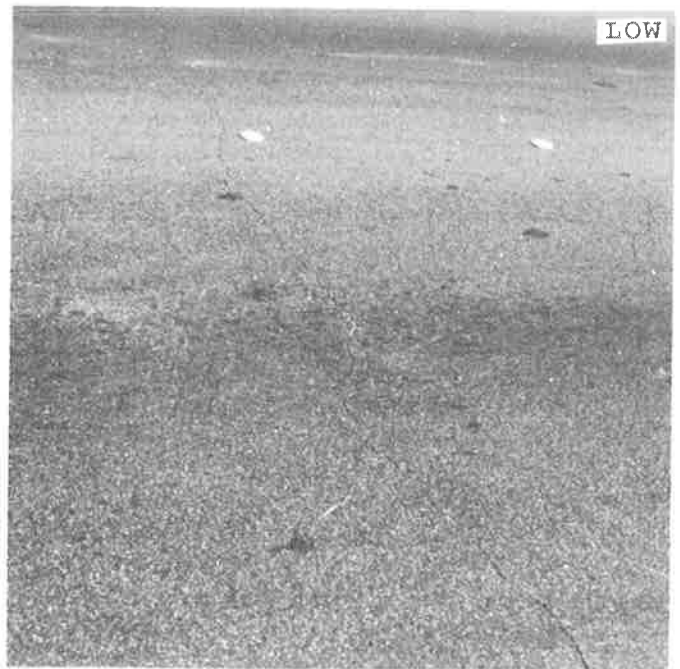
Low - Cracks with low severity or no spalling; mean unsealed crack width of $\frac{1}{4}$ " or less; sealant material in good condition.

Moderate - Cracks with moderate severity spalling; mean unsealed crack width of greater than $\frac{1}{4}$ "; sealant material in bad condition; low severity random cracking near the crack.

High - Cracks with high severity spalling; moderate or high severity random cracking near the crack.

How to Measure

Number and linear feet of transverse cracks at each severity level.



B. PATCHING AND POTHOLES

This section includes the following types of distress:

- 7. Patch/Patch Deterioration
- 8. Potholes

The general form of patching and potholes is illustrated in Figure 2.

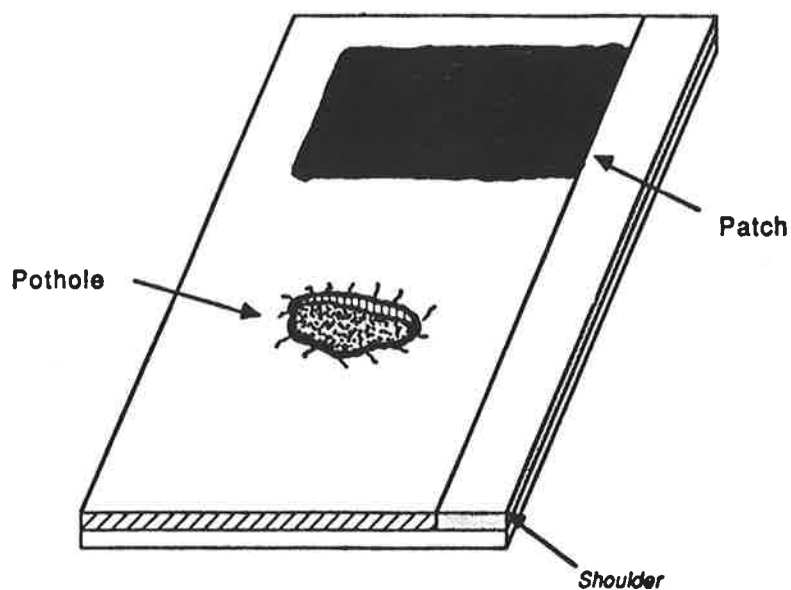


Figure 2. Patching and pothole of asphalt concrete pavement

ASPHALT CONCRETE PAVEMENTS

7. Patch/Patch Deterioration

Description

Portion of pavement surface that has been removed and replaced.

Severity Levels

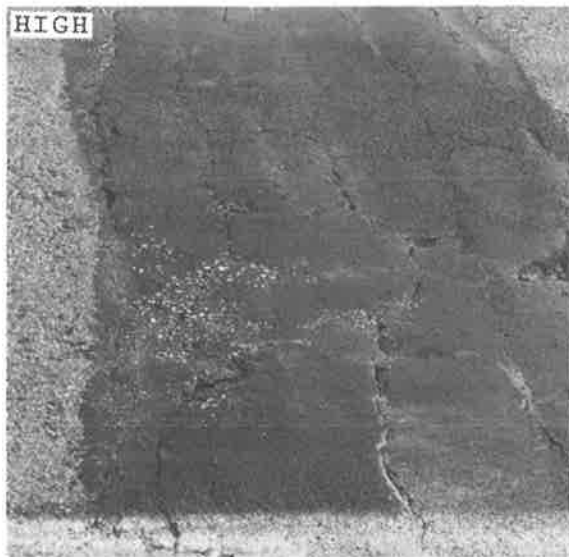
Low - Patch is in very good condition or has low severity distress of any type.

Moderate - Patch has moderate severity distress of any type.

High - Patch has high severity distress of any type.

How to Measure

Square feet of surface area and number of patches at each severity level.



8. Potholes

Description

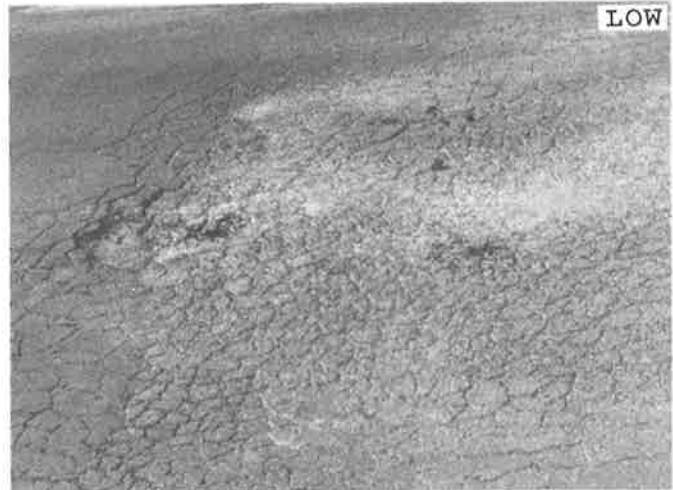
Bowl-shaped holes of various sizes in the pavement surface.

Severity Levels

	Area (Square Feet)		
Depth (Inches)	< 1	1 - 3	> 3
< 1	Low	Low	Moderate
1-2	Moderate	Moderate	High
> 2	Moderate	High	High

How to Measure

Number of potholes at each severity level.



C. SURFACE DEFORMATION

This section includes the following types of surface deformation:

- 9. Rutting
- 10. Shoving

The general form of the various types of surface deformation are illustrated in Figure 3.

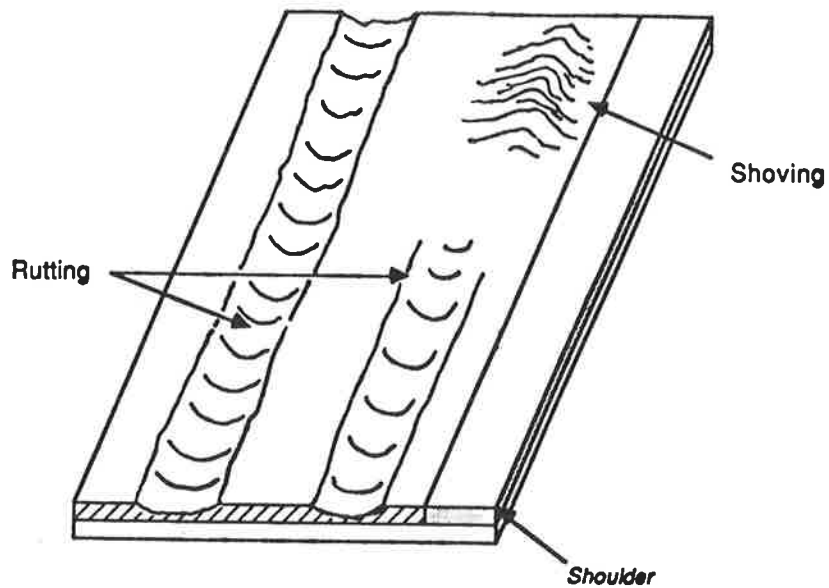


Figure 3. Surface deformation of asphalt concrete pavement

9. Rutting

Description

Longitudinal surface depression in the wheel path.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of rut depth as measured below.

How to Measure

Maximum rut depth in inches to the nearest 1/10" at 50' intervals for each wheelpath.



ASPHALT CONCRETE PAVEMENTS

10. Shoving

Description

Longitudinal displacement of a localized area of the pavement surface caused by traffic pushing against the pavement.

Severity Levels

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

How to Measure

Number of occurrences and square feet of surface area.



D. SURFACE DEFECTS

This section includes the following types of surface defects:

11. Bleeding
12. Polished Aggregate
13. Raveling and Weathering

The general form of the various types of surface distress is illustrated in Figure 4.

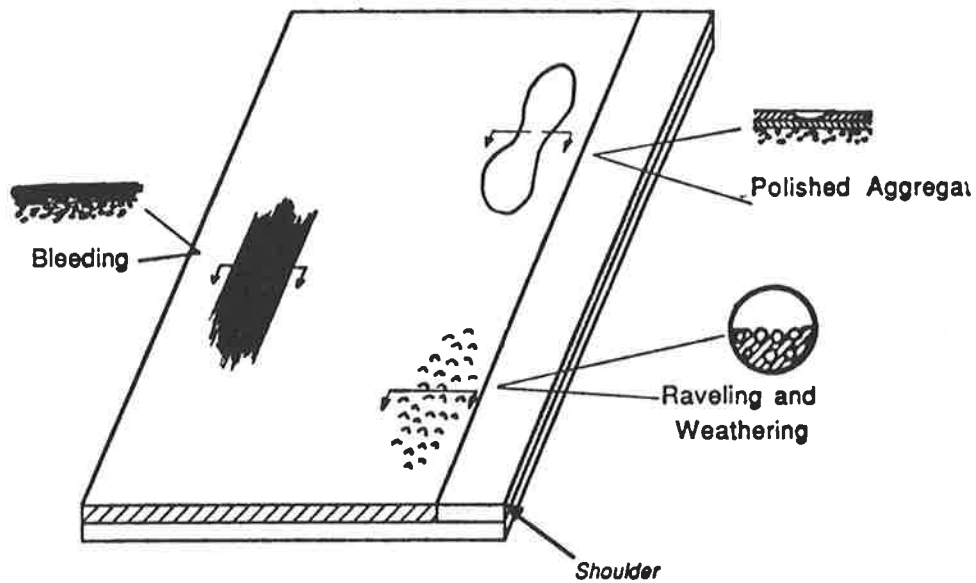


Figure 4. Surface defects of asphalt concrete pavement

ASPHALT CONCRETE PAVEMENTS

11. Bleeding

Description

A film of bituminous material on pavement surface which creates a shiny, glass-like, reflective surface that may be tacky to the touch.

Severity Levels

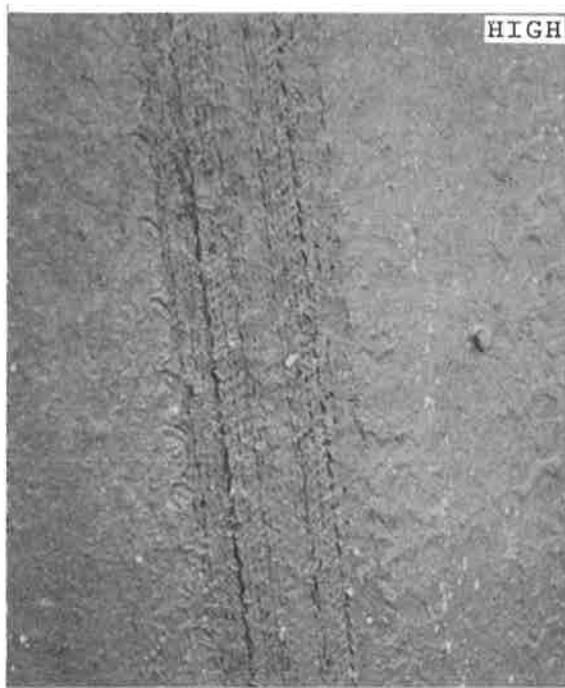
Low - Coloring of pavement surface visible.

Moderate - Distinctive appearance with excess asphalt already free.

High - Free asphalt gives the pavement surface a wet look; tire marks are evident.

How to Measure

Square feet of surface area.



12. Polished Aggregate

Description

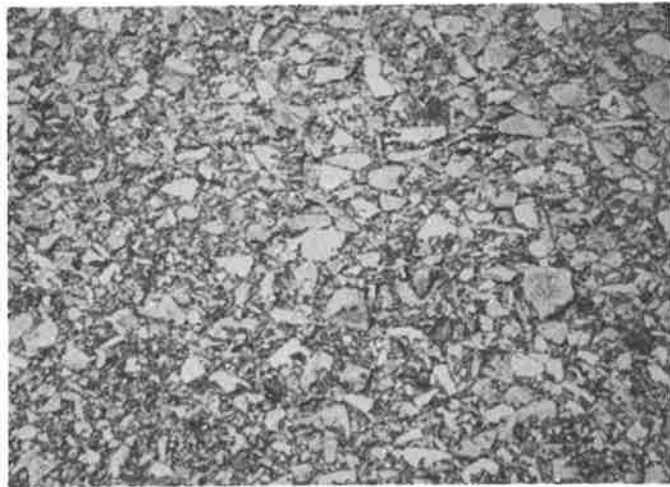
Surface worn away to expose coarse aggregate which are glossy in appearance and smooth to the touch.

Severity Levels

Not applicable. However, the degree of polishing may be reflected in a reduction of skid resistance.

How to Measure

Square feet of surface area.



ASPHALT CONCRETE PAVEMENTS

13. Raveling and Weathering

Description

Wearing away of the pavement surface caused by the dislodging of aggregate particles (raveling) and loss of asphalt binder (weathering).

Severity Levels

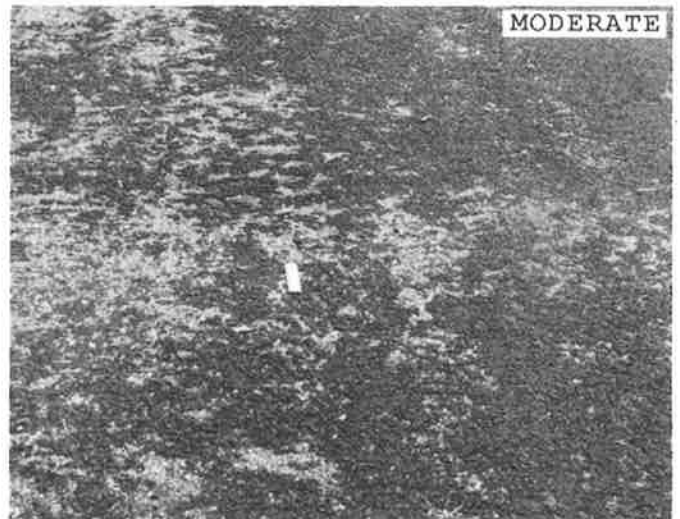
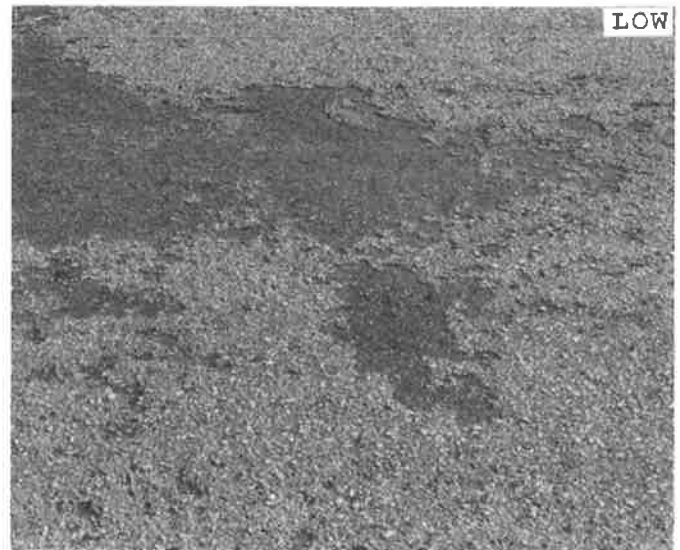
Low - Wearing away of the aggregate or binder has started but has not progressed significantly.

Moderate - Aggregate and/or binder has worn away and the surface texture is becoming rough and pitted; loose particles generally exist.

High - Aggregate and/or binder has worn away and the surface texture is very rough and pitted.

How to Measure

Square feet of surface area at each severity level.



E. MISCELLANEOUS DISTRESSES

This section includes the following miscellaneous distresses:

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

The general form of the various miscellaneous distresses is illustrated in Figure 5.

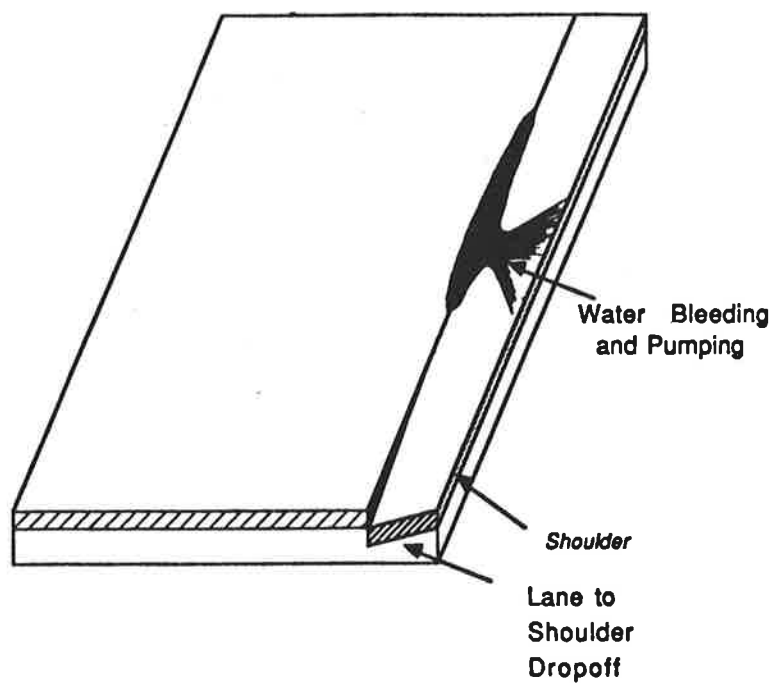


Figure 5. Miscellaneous distresses of asphalt concrete pavement

ASPHALT CONCRETE PAVEMENTS

14. Lane-to-Shoulder Dropoff

Description

Difference in elevation between the traffic lane and outside shoulder; typically occurs when the outside shoulder settles.

Severity Level

Not applicable. However, severity levels can be defined in relation to inches of lane-to-shoulder dropoff as measured below.

How to Measure

- In inches to the nearest 1/10" at intervals of 100' along the lane-to-shoulder joint.
- If heave of the shoulder occurs (upward movement), rate as a negative (-) value.



15. Lane-to-Shoulder Separation

Description

Widening of the joint between the traffic lane and the shoulder.

Severity Levels

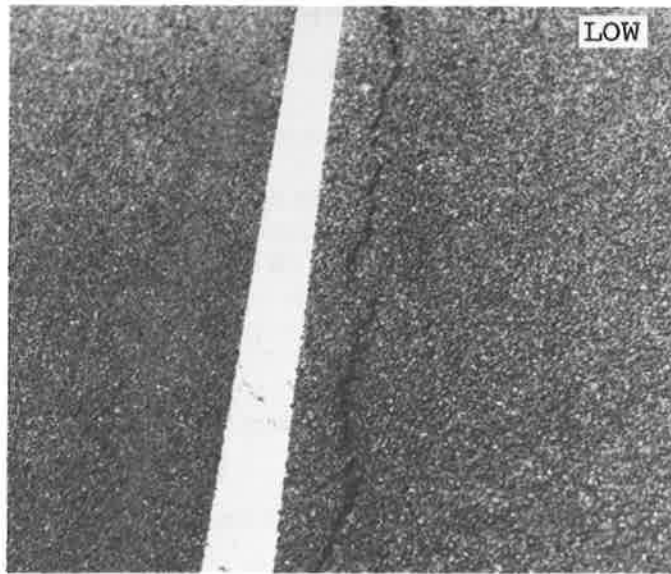
Low - cracks with low severity or no spalling; mean unsealed crack width of 1/4" or less; sealant material in good condition.

Moderate - Cracks with moderately severe spalling; mean unsealed crack width of greater than 1/4" sealant material in bad condition; low severity random cracking near the crack.

High - Cracks with high severity spalling; moderate or high severity random cracking near the cracks.

How to Measure

Linear feet at each severity level.



ASPHALT CONCRETE PAVEMENTS

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

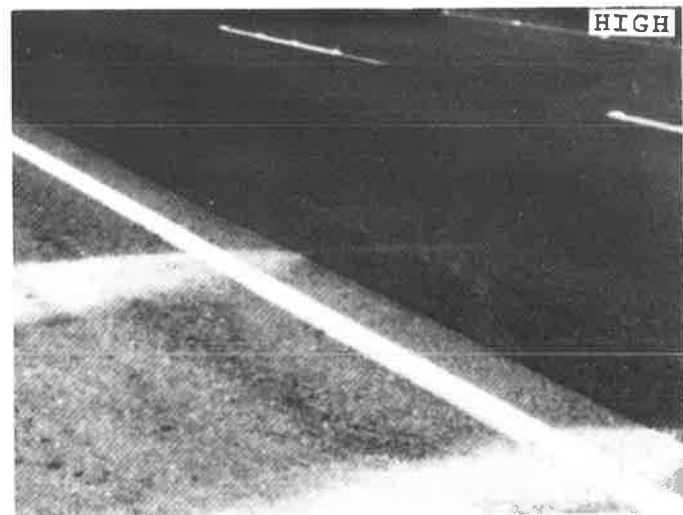
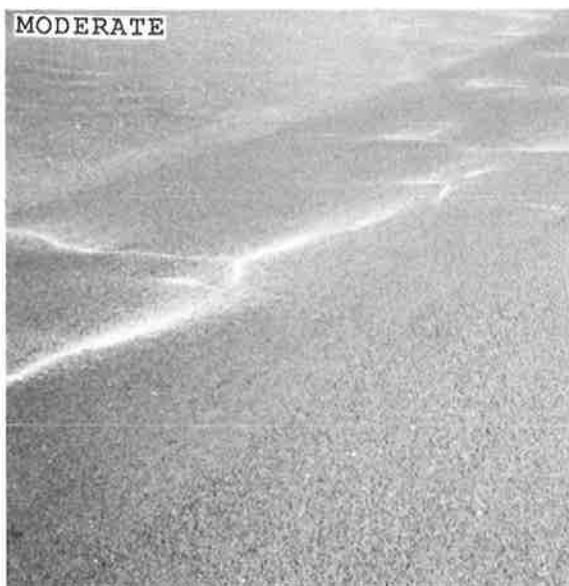
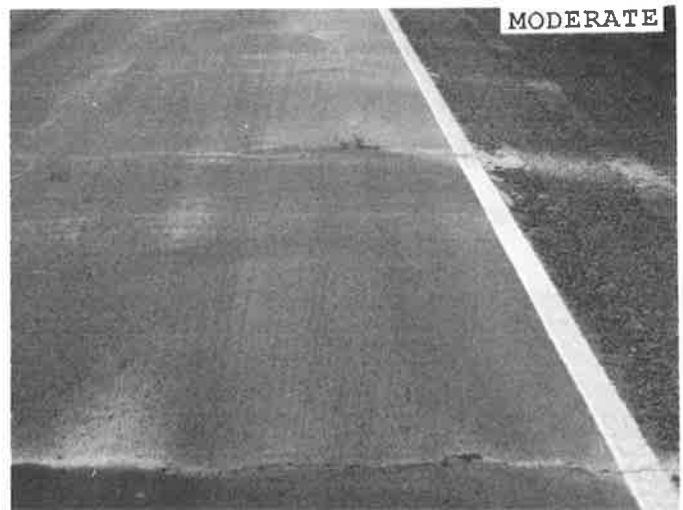
Low - Some water bleeding is present; no fines can be seen on the surface.

Moderate - Some pumped material (fines) exists near cracks.

High - A significant amount of pumped material (fines) exists near cracks.

How to Measure

Number and linear feet of effected cracks at each severity level.



2

Distresses for Pavements with Jointed Portland Cement Concrete Surfaces

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

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

Table 2 presents a summary of distresses, severity levels, and units of measurement.

Table 2. Jointed concrete surfaced pavement distress types.

<i>Distress Type</i>	<i>Units of Measurements</i>	<i>Defined Severity Levels</i>
<i>Cracking</i>		
1. Corner Breaks	Number	Yes
2. Durability "D" Cracking	No., Sq.Ft.	Yes
3. Longitudinal Cracking	Linear Feet	Yes
4. Transverse Cracking	No., Ln.Ft.	Yes
<i>Joint Deficiencies</i>		
5. Joint Seal Damage of Transverse Joints	No., Ln.Ft.	Yes
6. Spalling of Longitudinal Joints	Linear Feet	Yes
7. Spalling of Transverse Joints	No., Ln.Ft.	Yes
<i>Surface Defects</i>		
8. Map Cracking and Scaling	Square Feet	Yes
9. Polished Aggregate	Square Feet	No
10. Popouts	Number	No
<i>Miscellaneous Distress</i>		
11. Blowup	Number	No
12. Faulting of Transverse Joints & Cracks	Inches	No
13. Lane-to-Shoulder Dropoff	Inches	No
14. Lane-to-Shoulder Separation	Inches	No
15. Patch/Patch Deterioration	Sq.Ft.,No.	Yes
16. Water Bleeding and Pumping	No., Ln.Ft.	Yes

A. CRACKING

This section includes the following types of cracking:

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

The general form of the various types of cracking is illustrated in Figure 6.

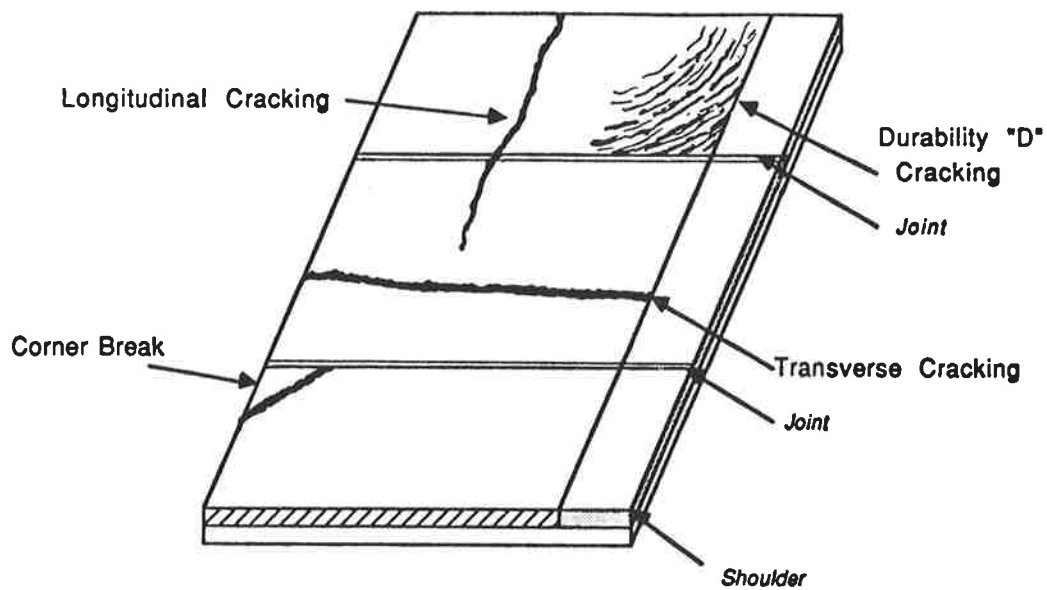


Figure 6. Cracking of jointed concrete pavement

JOINTED CONCRETE PAVEMENTS

1. Corner Breaks

Description

- Crack at corner of slab.
- Crack intersects the joints less than 6' from the corner on each side.

Severity Levels

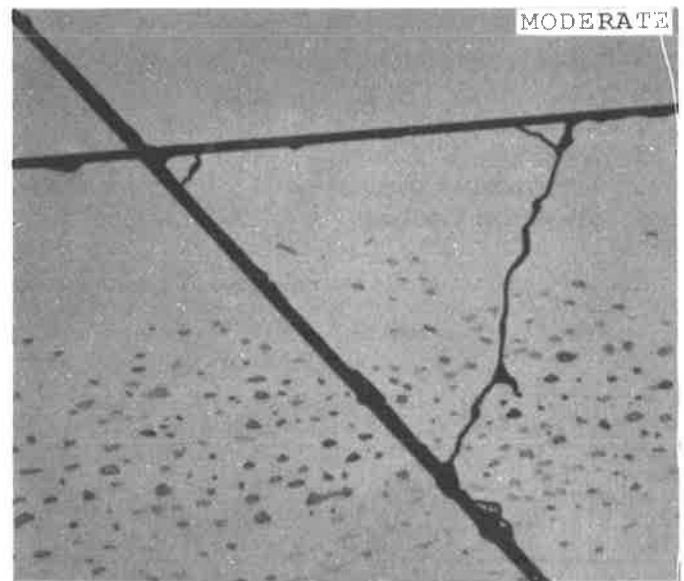
Low - Crack well sealed or hairline; no faulting or break-up; crack not spalled.

Moderate - Crack spalled at low or moderate severity; no break-up; faulting of crack or joint less than 1/2".

High - Crack spalled at high severity, or corner piece broken into two or more pieces, or faulting of crack or joint more than 1/2".

How to Measure

Number of corner breaks at each severity level.



2. Durability "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.

Severity Levels

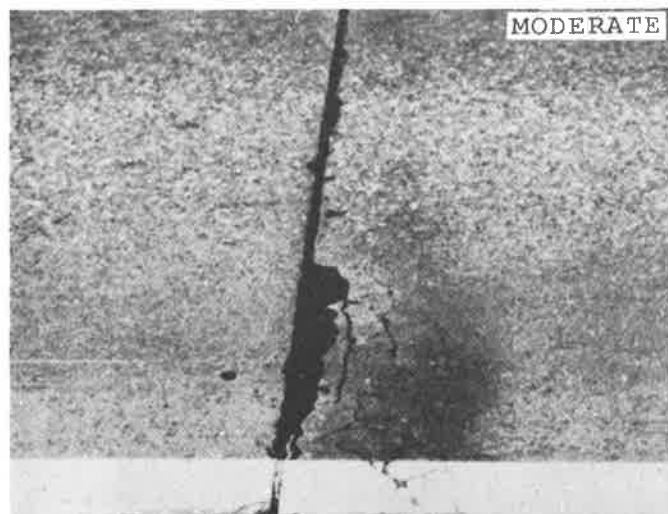
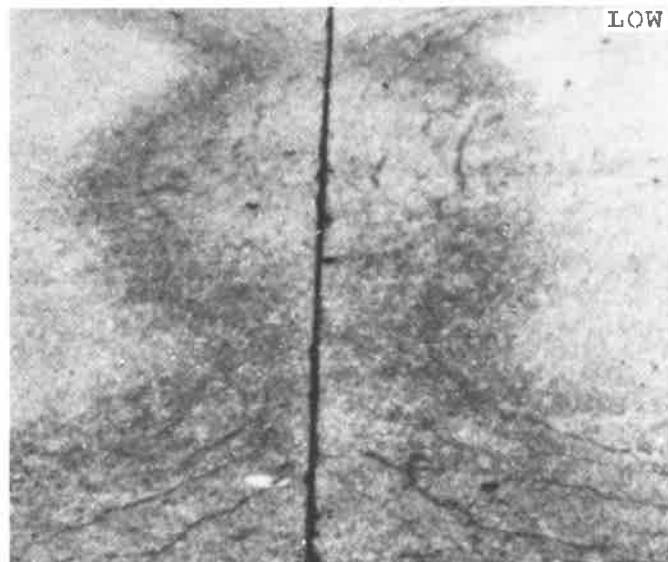
Low - Width of effected area is less than 12" from the center of the joint or crack; no spalling or patching in the effected area.

Moderate - Width of the effected area is 12" or more from the center of the joint or crack; low or moderate severity spalling has developed in effected area.

High - High severity spalling with considerable loose material exists in the effected area; cracking pattern over entire slab.

How to Measure

Square feet and number of effected joints or cracks (including longitudinal) at each severity level.



JOINTED CONCRETE PAVEMENTS

3. Longitudinal Cracking

Description

Cracks relatively parallel to pavement centerline.

Severity Levels

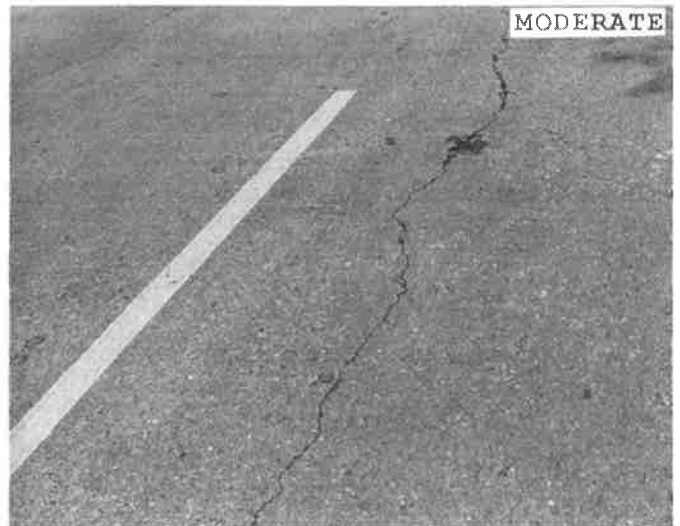
Low - Well sealed or hairline cracks with no spalling or faulting.

Moderate - Cracks with low or moderate severity spalling; faulting less than 1/2"; crack widths 1/2" or less.

High - Cracks with high severity spalling; faulting 1/2" or more; crack widths greater than 1/2".

How to Measure

Linear feet at each severity level.



4. Transverse Cracking

Description

Cracks relatively perpendicular to pavement centerline.

Severity Levels

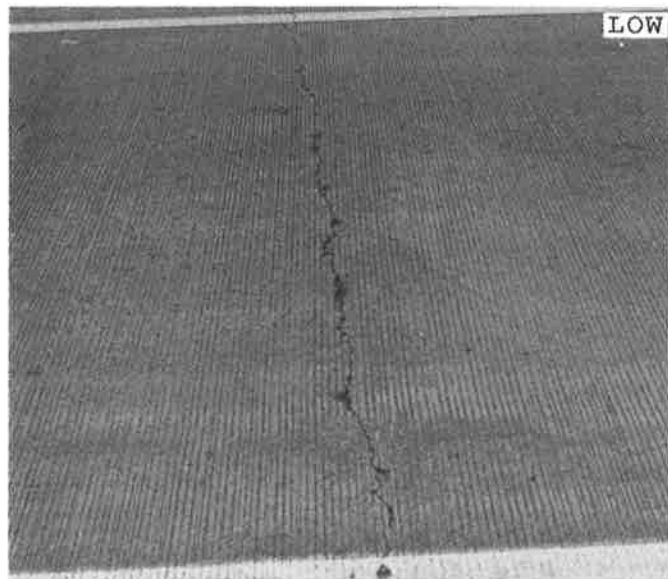
Low - Hairline cracks with no spalling or faulting.

Moderate - Cracks with low severity spalling; faulting less than 1/4"; crack widths 1/2" or less.

High - Cracks with moderate or high severity spalling; faulting 1/4" or more; crack width greater than 1/2".

How to Measure

Number and linear feet of transverse cracks at each severity level.



B. JOINT DEFICIENCIES

This section includes the following types of joint deficiencies:

5. Joint Seal Damage of Transverse Joints
6. Spalling of Longitudinal Joints
7. Spalling of Transverse Joints

The general form of the various types of joint deficiencies is illustrated in Figure 7.

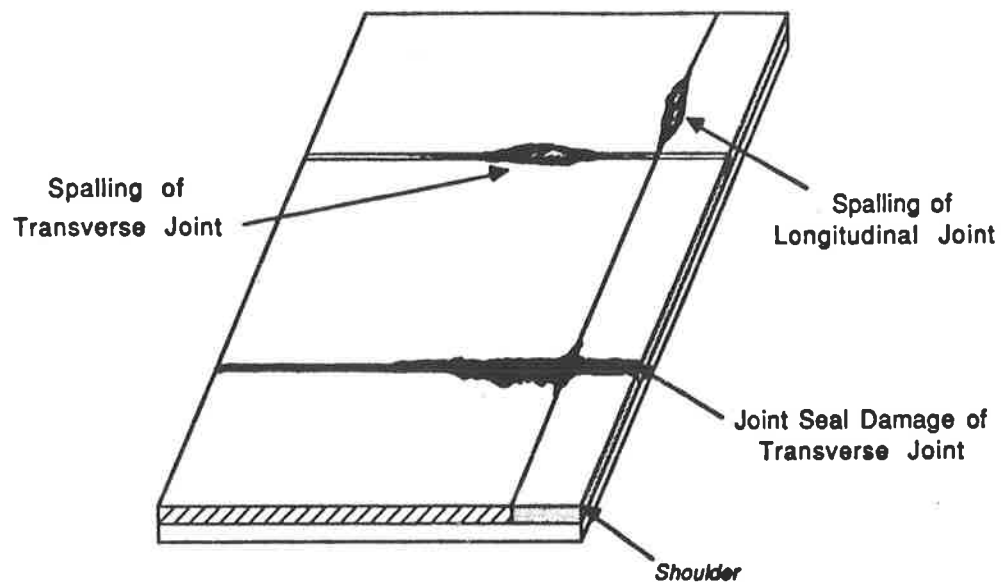


Figure 7. Joint deficiencies of jointed concrete pavement

5. Joint Seal Damage of Transverse Joints

Description

- Extrusion, hardening, adhesive failure (bonding), cohesive failure (splitting), or complete loss of the sealant.
- Weed growth in the joint.

Severity Levels

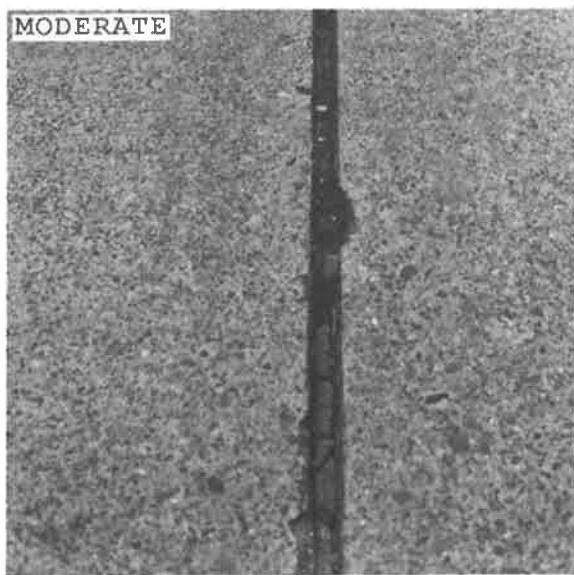
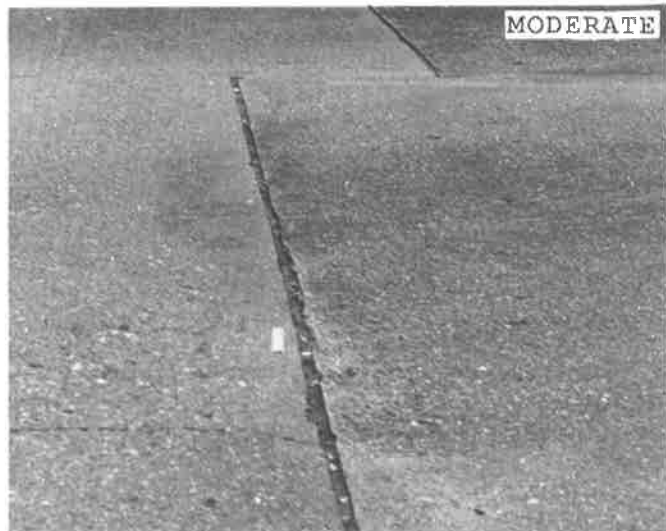
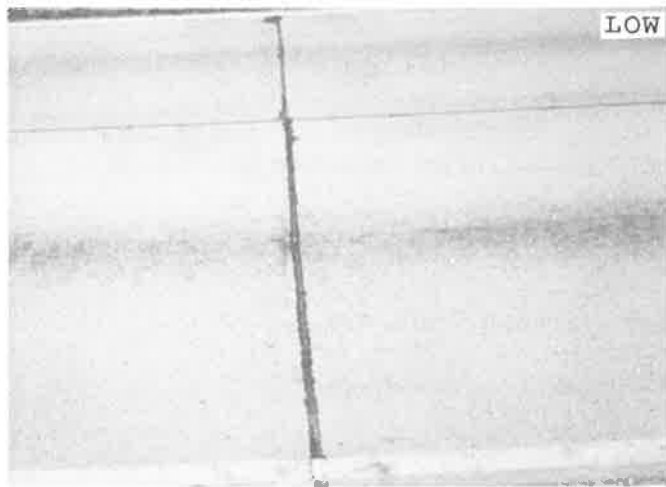
Low - Joint seal damage as described above exists over less than 25% of the joint.

Moderate - Joint seal damage as described above exists over 25-50% of the joint.

High - Joint seal damage as described above exists over more than 50% of the joint.

How to Measure

Number and linear feet of transverse joints at each severity level.



JOINTED CONCRETE PAVEMENTS

6. Spalling of Longitudinal Joints

Description

Cracking, breaking, chipping, or fraying of slab edges within 2" of the longitudinal (lane-to-lane) joint.

Severity Levels

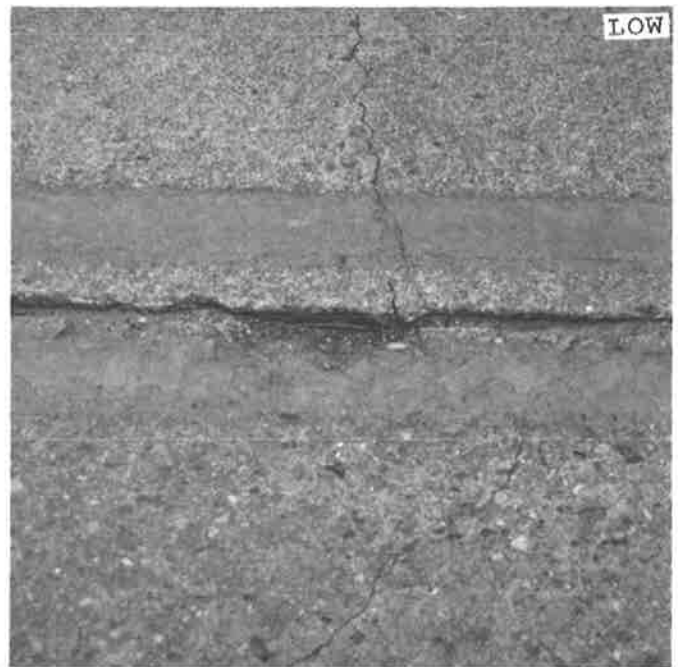
Low - Less than 3" wide spalls.

Moderate - 3" to 6" wide spalls.

High - Greater than 6" wide spalls.

How to Measure

Linear feet at each severity level.



7. Spalling of Transverse Joints

Description

Cracking, breaking, chipping, or fraying of slab edges within 2' of transverse joint.

Severity Level

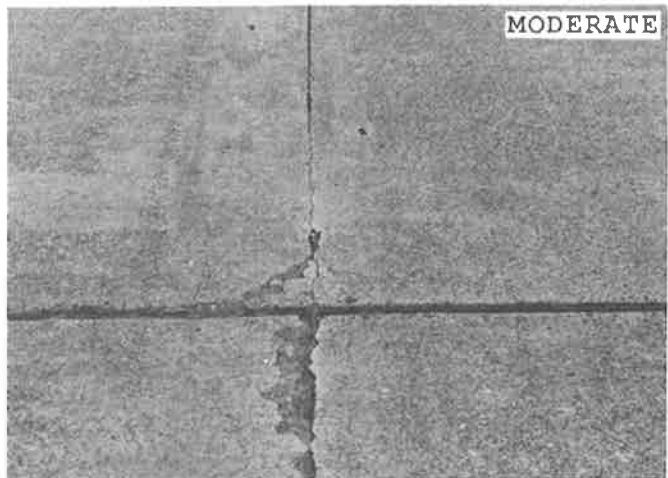
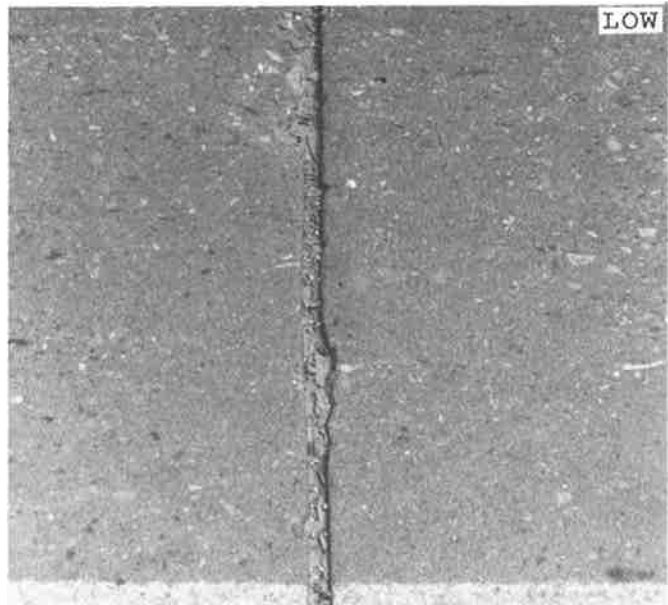
Low - Less than 3" wide spalls.

Moderate - 3" to 6" wide spalls.

High - Greater than 6" wide spalls.

How to Measure

Number and linear feet of joints at each severity level.



C. SURFACE DEFECTS

This section includes the following types of surface defects:

8. Map Cracking and Scaling
9. Polished Aggregate
10. Popouts

The general form of the various types of surface defects is illustrated in Figure 8.

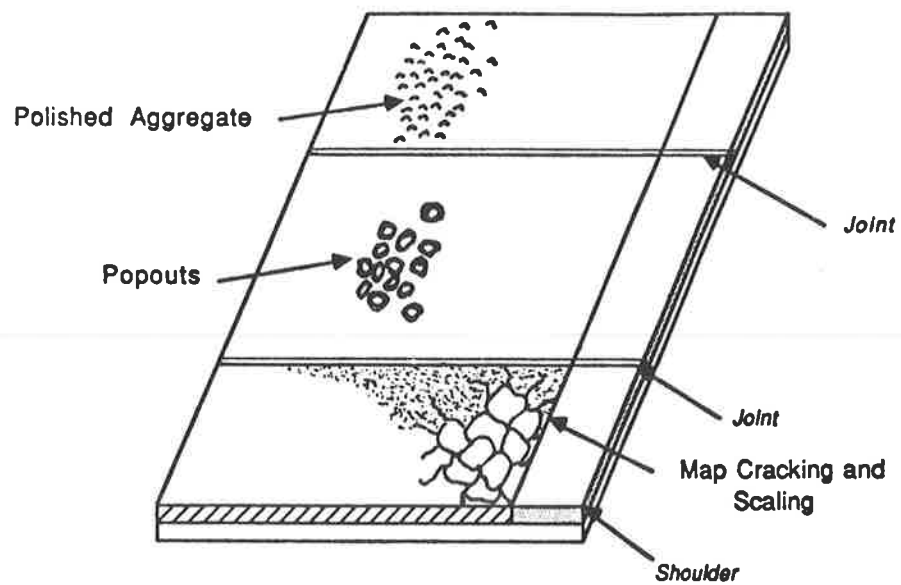


Figure 8. Surface defects of jointed concrete pavement

8. Map Cracking and Scaling

Description

- **Map cracking** is a series of cracks that extend only into the upper surface of the slab.
- **Scaling** is the deterioration of the slab surface to a depth of approximately 1/8" to 1/2", resulting in the loss of surface mortar.

Severity Levels

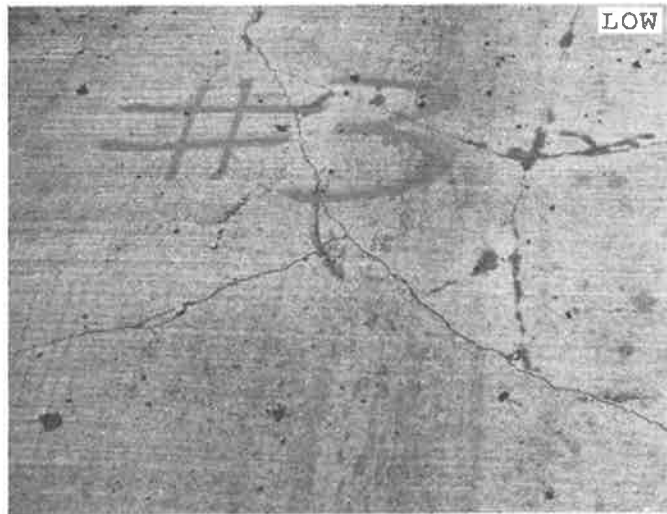
Low - Effected area consists of map cracking with no scaling present.

Moderate - Scaling is present but less than 10% of effected area exhibits scaling.

High - More than 10% of effected area exhibits scaling.

How to Measure

Square feet of surface area.



JOINTED CONCRETE PAVEMENTS

9. Polished Aggregate

Description

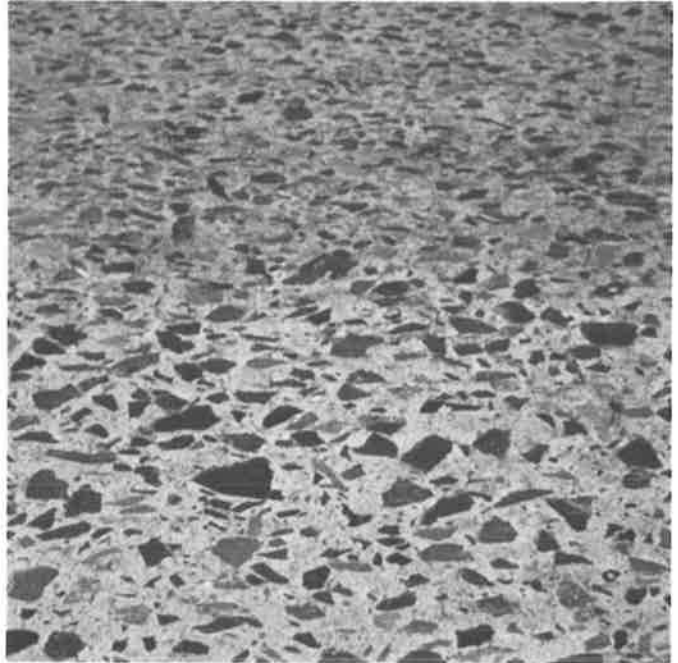
Surface mortar and texturing worn away to expose coarse aggregate, which is glossy in appearance and smooth to the touch.

Severity Levels

Not applicable. However, the degree of polishing may be reflected in a reduction of skid resistance.

How to Measure

Square feet of surface area.



10. Popouts

Description

Small pieces of pavement broken loose from surface; ranging in diameter from 1" to 4" and depth from 1/2" to 2".

Severity Levels

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

How to Measure

Number of popouts.



D. MISCELLANEOUS DISTRESSES

This section includes the following types of miscellaneous 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

The general form of the various types of miscellaneous distresses is illustrated in Figure 9.

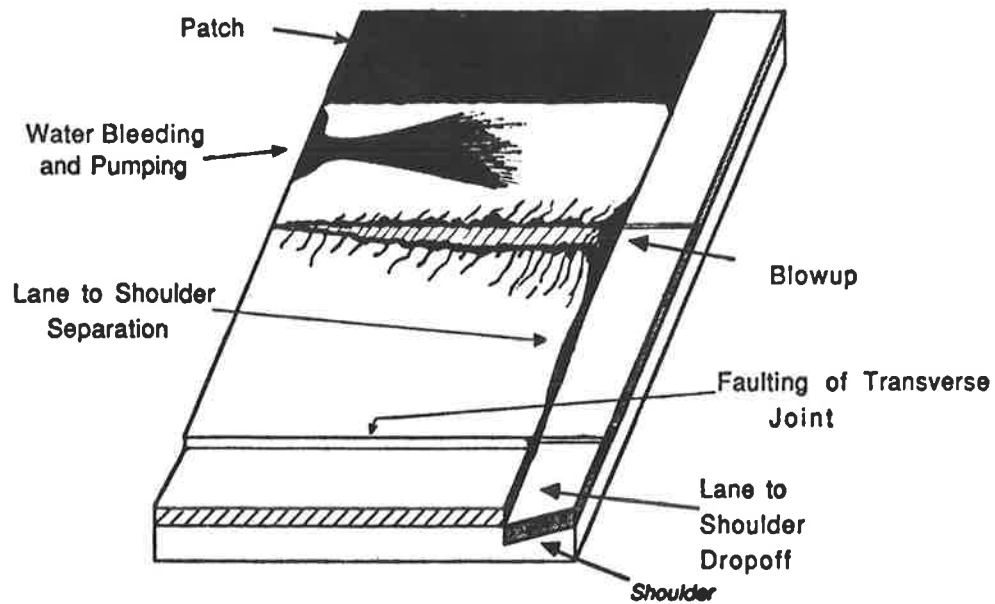


Figure 9. Miscellaneous distresses of jointed concrete pavement

11. Blowups

Description

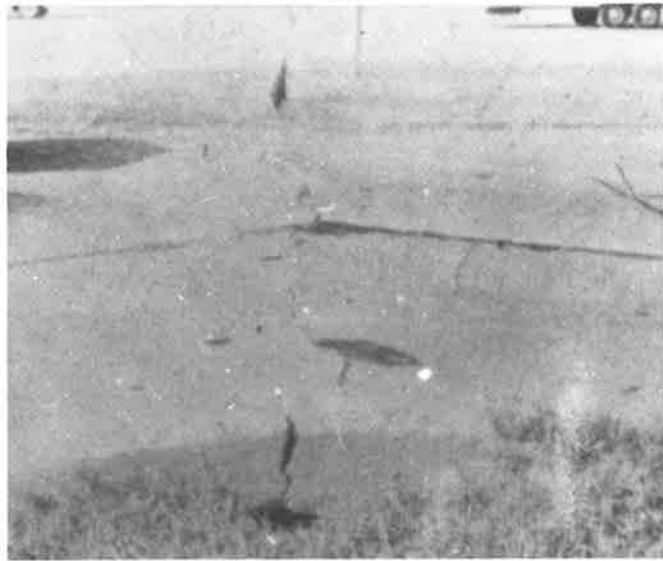
Localized upward movement of the pavement surface at transverse joints or cracks, often accompanied with shattering of the concrete in that area.

Severity Level

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

How to Measure

Number of blowups.



12. Faulting of Transverse Joints and Cracks

Description

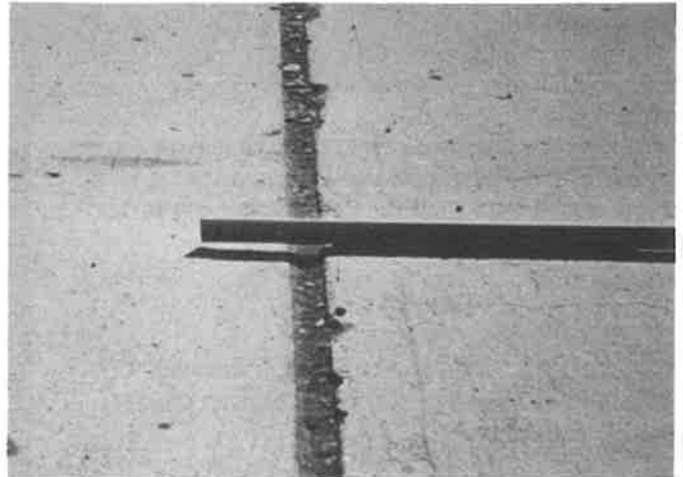
Difference in elevation across a joint or crack.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of faulting as measured below.

How to Measure

- In inches to the nearest 1/10"; 1' from the outside slab edge.
- If "approach" slab is higher than "departure" slab, faulting is positive (+); if approach slab is lower, faulting is negative (-).



13. Lane-to-Shoulder Dropoff

Description

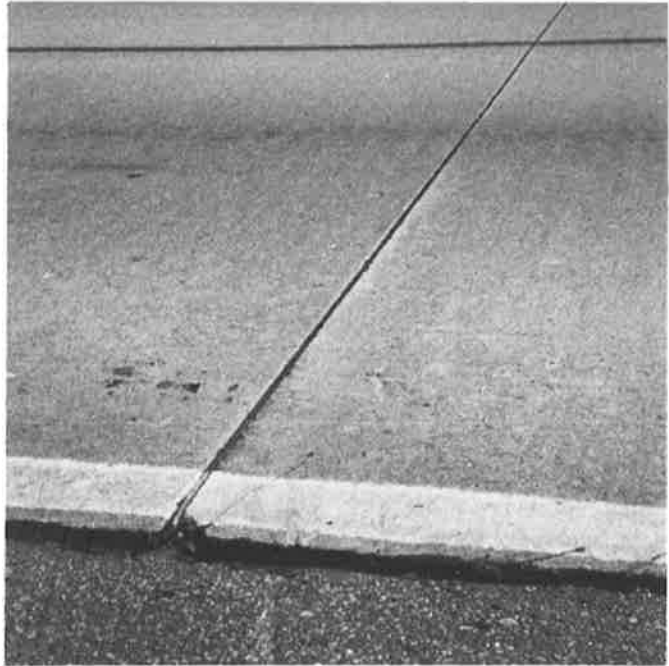
Difference in elevation between the traffic lane and outside shoulder; typically occurs when the outside shoulder settles.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of lane-to-shoulder dropoff as measured below.

How to Measure

- In inches to the nearest 1/10" at 100' intervals along the lane-to-shoulder joint.
- If heave of the shoulder occurs (upward movement), rate as a negative (-) value.



JOINTED CONCRETE PAVEMENTS

14. Lane-to-Shoulder Separation

Description

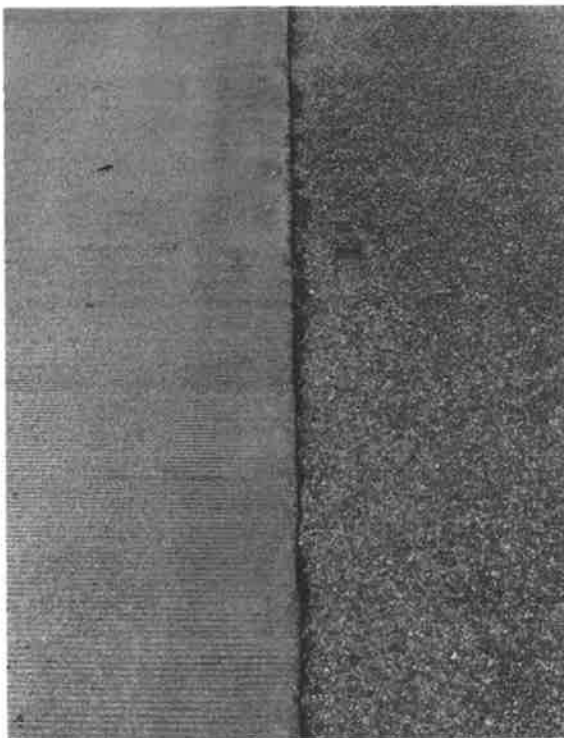
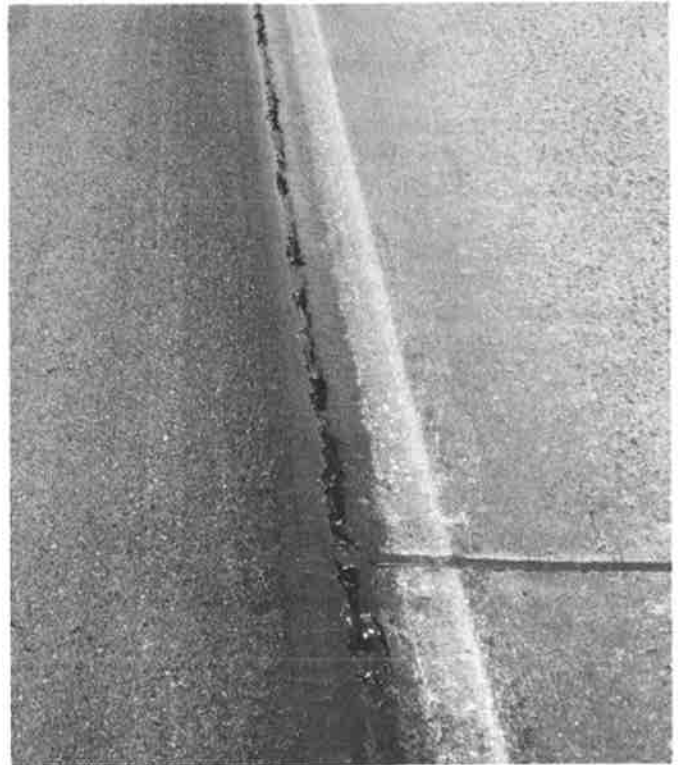
Widening of the joint between the traffic lane and the shoulder.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of lane-to-shoulder separation as measured below.

How to Measure

In inches to the nearest 1/10" at 100' intervals along the lane-to-shoulder joint.



15. Patch/Patch Deterioration

Description

Portion of the original concrete slab that has been removed and replaced.

Severity Levels

Low - Patch is in very good condition or has low severity distress of any type; faulting or settlement less than 1/4".

Moderate - Patch has moderate severity distress of any type; faulting or settlement 1/4 to 1/2".

High - Patch has high severity distress of any type; faulting or settlement greater than 1/2".

How to Measure

Square feet of surface area and number of patches at each severity level by material type—rigid vs. flexible.



16. Water Bleeding and Pumping

Description

- Seeping or ejection of water from beneath the slab through joints and 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

Low - Some water bleeding is present; no fines can be seen on the surface.

Moderate - Some pumped material (fines) exists near joints or cracks; small semi-circular (6" to 12" radii) depressions may begin to form in AC shoulders adjacent to the pumping joints or cracks.

High - A significant amount of pumped material (fines) exists near joints or cracks; depressions in AC shoulders may exist with some patching.

How to Measure

Number and lineal feet of effected joints and cracks at each severity level.



3

Distresses for Pavements with Continuously Reinforced Concrete Surfaces

This section covers continuously reinforced concrete surfaced pavements, including continuously reinforced concrete overlays of portland cement concrete pavements. Each of the distresses has been grouped into one of the following general modes:

- A. Cracking
- B. Surface Defects
- C. Miscellaneous Distresses

Table 3 presents a summary of distresses, severity levels, and units of measurement.

Table 3. Continuously reinforced concrete surfaced pavement distress types.

<i>Distress Type</i>	<i>Unit of Measurement</i>	<i>Defined Severity Levels</i>
<i>Cracking</i>		
1. Durability "D" Cracking	No., Sq. Ft.	Yes
2. Longitudinal Cracking	Linear Feet	Yes
3. Transverse Cracking	No., Sq. Ft.	Yes
<i>Surface Defects</i>		
4. Map Cracking and Scaling	Square Feet	Yes
5. Polished Aggregate	Square Feet	No
6. Popouts	Number	No
<i>Miscellaneous Distress</i>		
7. Blowups	Number	No
8. Construction Joint Deterioration	Number	Yes
9. Lane-to-Shoulder Dropoff	Inches	No
10. Lane-to-Shoulder Separation	Inches	No
11. Patch/Patch Deterioration	Square Feet, Number	Yes
12. Punchouts	Number	Yes
13. Spalling of Longitudinal Joint	Linear Feet	Yes
14. Water Bleeding and Pumping	No., Ln. Ft.	Yes

A. CRACKING

This section includes the following types of cracking:

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

The general form of the various types of cracking is illustrated in Figure 10.

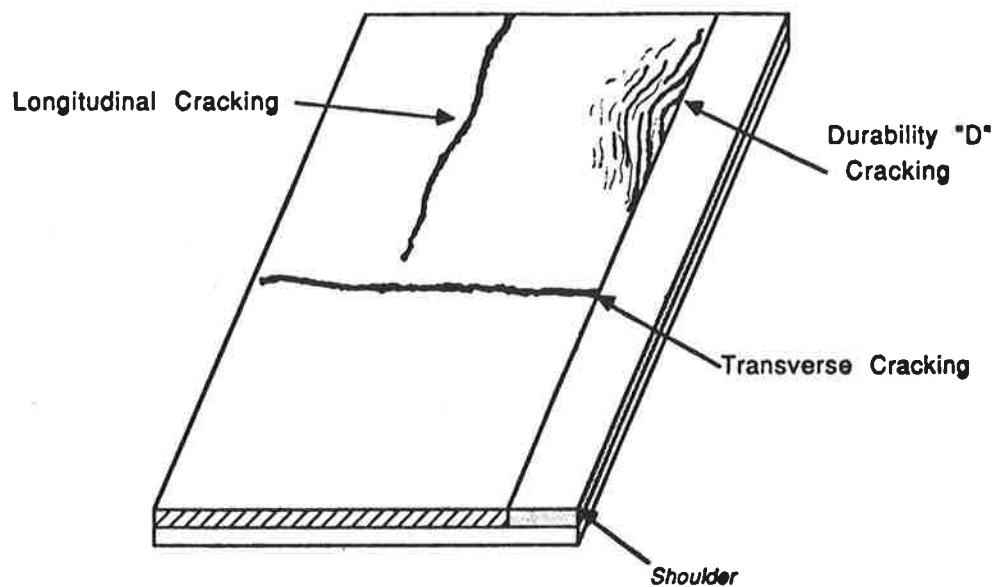


Figure 10. Cracking of continuously reinforced concrete pavement

CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

1. Durability "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.

Severity Levels

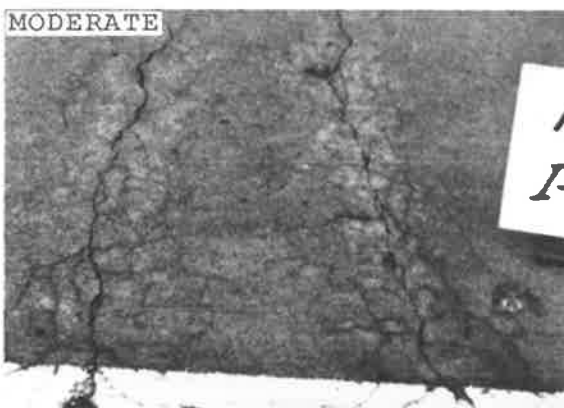
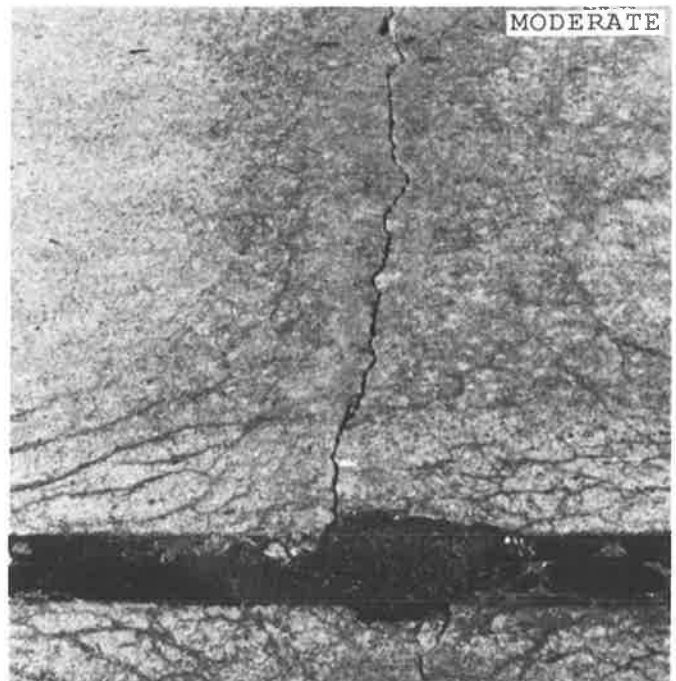
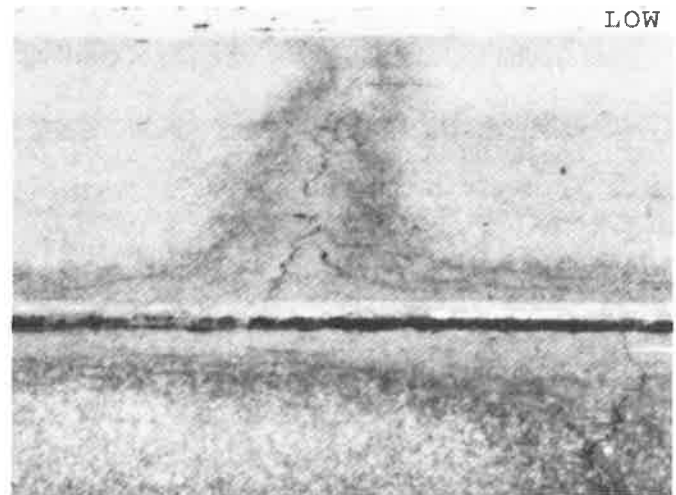
Low - Width of effected area is less than 12" from the center of the joint or crack; no spalling or patching in the effected area.

Moderate - Width of the effected area is 12" or more from the center of the joint or crack; low or moderate severity spalling has developed in effected area.

High - High severity spalling with considerable loose material exists in the effected area; cracking pattern over entire slab.

How to Measure

Number and square feet of effected joints or cracks (including longitudinal) at each severity level.



2. Longitudinal Cracking

Description

Cracks relatively parallel to pavement centerline.

Severity Levels

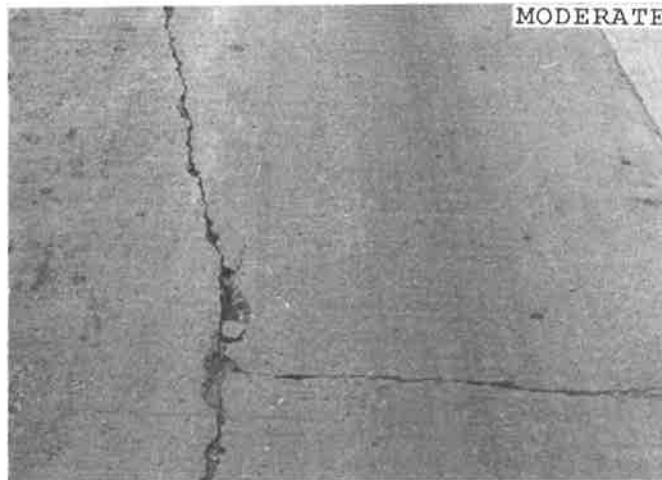
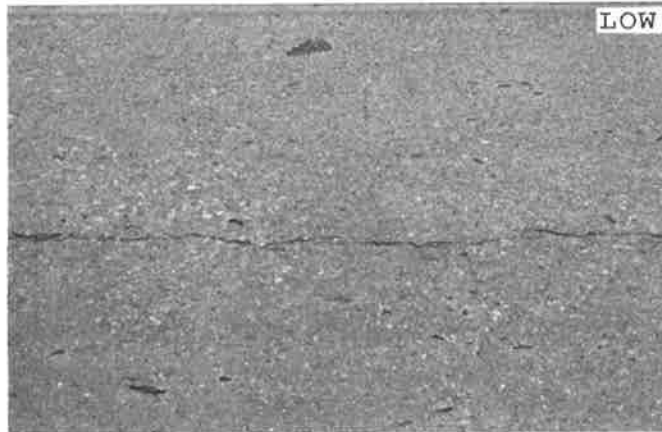
Low - Well-sealed or hairline cracks with no spalling or faulting.

Moderate - Cracks with low or moderate severity spalling; faulting less than 1/2", crack widths 1/2" or less.

High - Cracks with high severity spalling; faulting 1/2" or more; crack widths greater than 1/2".

How to Measure

Linear feet at each severity level.



CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

3. Transverse Cracking

Description

Cracks relatively perpendicular to pavement centerline.

Severity Levels

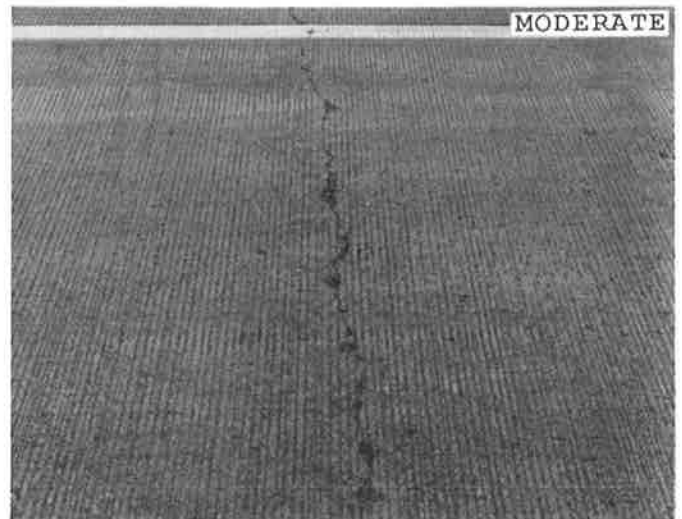
Low - Hairline cracks with no spalling or faulting.

Moderate - Cracks with low severity spalling; faulting less than 1/4"; crack widths 1/8" or less.

High - Cracks with moderate or high severity spalling; faulting 1/4" or more; crack width greater than 1/8".

How to Measure

Number and linear feet of transverse cracks at each severity level.



B. SURFACE DEFECTS

This section includes the following types of surface defects:

4. Map Cracking and Scaling
5. Polished Aggregate
6. Popouts

The general form of the various types of surface distress is illustrated in Figure 11.

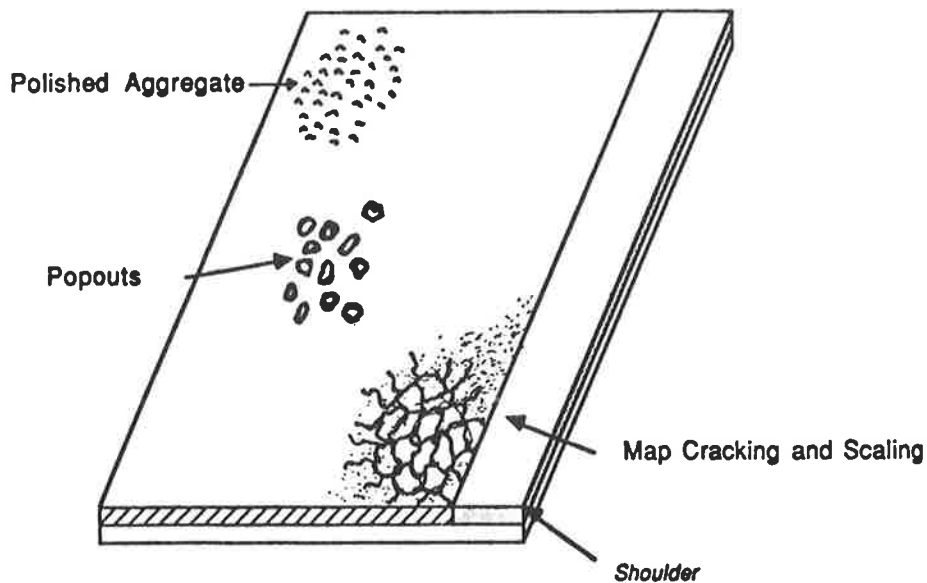


Figure 11. Surface defects of continuously reinforced concrete pavement

CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

4. Map Cracking and Scaling

Description

- **Map cracking** is a series of cracks that extend only into the upper surface of the slab.
- **Scaling** is the deterioration of the slab surface to a depth of approximately 1/8" to 1/2", resulting in the loss of surface mortar.

Severity Levels

Low - Effected area consists of map cracking with no scaling present.

Moderate - Scaling is present but less than 10% of effected area exhibits scaling.

High - More than 10% of effected area exhibits scaling.

How to Measure

Square feet of surface area.



5. Polished Aggregate

Description

Surface mortar and texturing worn away to expose coarse aggregate which is glossy in appearance and smooth to the touch.

Severity Levels

Not applicable. However, the degree of polishing may be reflected in a reduction of skid resistance.

How to Measure

Square feet of surface area.



CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

6. Popouts

Description

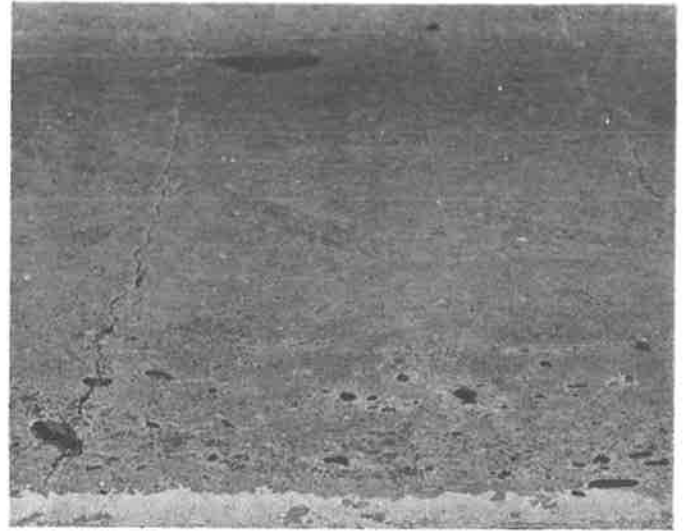
Small pieces of pavement broken loose from surface; ranging in diameter from 1" to 4", and depth from 1/2" to 2".

Severity Levels

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

How to Measure

Number of popouts.



C. MISCELLANEOUS DISTRESSES

This section includes the following miscellaneous distresses:

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

The general form of the various miscellaneous distresses is illustrated in Figure 12.

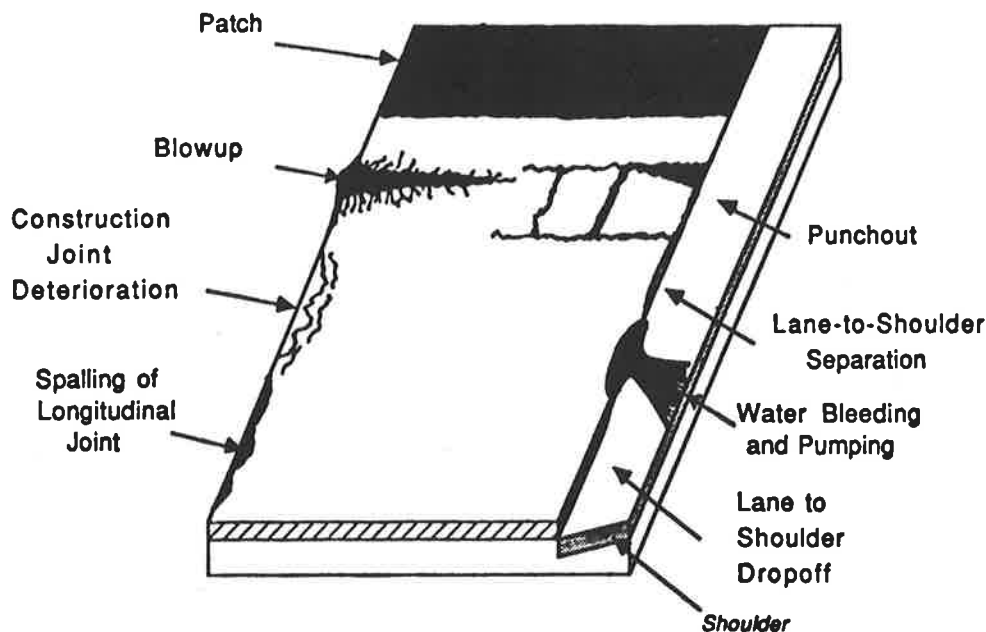


Figure 12. Miscellaneous defects of continuously reinforced concrete pavement

CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

7. Blowups

Description

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

Severity Level

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

How to Measure

Number of blowups.



8. Construction Joint Deterioration

Description

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

Severity Levels

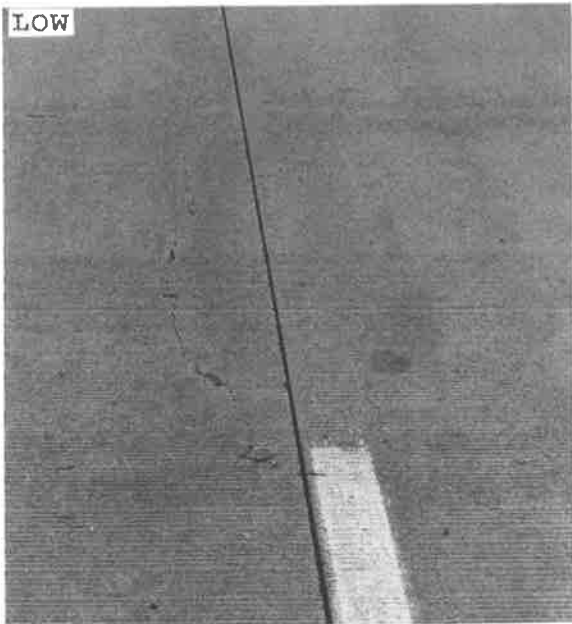
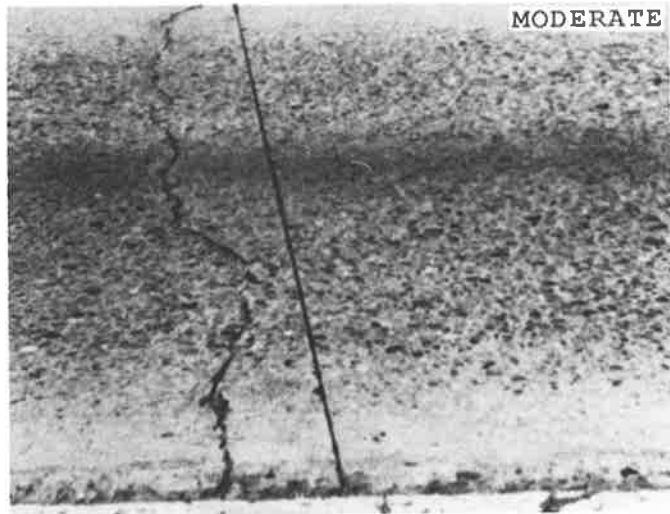
Low - Closely spaced tight cracks with no spalling or faulting within 10' of construction joint.

Moderate - Low severity spalling exists within 10' of construction joint.

High - Moderate or high severity spalling and breakup exists within 10' of construction joint.

How to Measure

Number of construction joints at each severity level.



CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

9. Lane-to-Shoulder Dropoff

Description

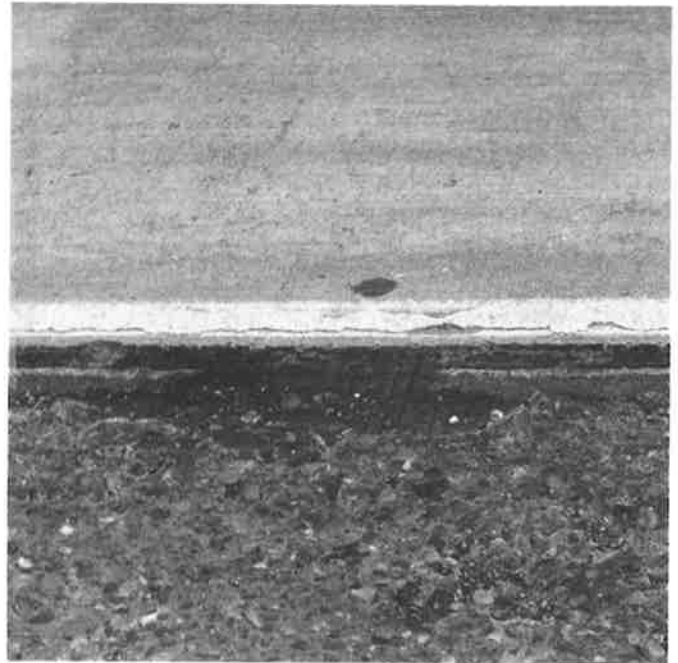
Difference in elevation between the traffic lane and outside shoulder; typically occurs when the outside shoulder settles.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of lane-to-shoulder dropoff as measured below.

How to Measure

- In inches to the nearest 1/10" at 100' intervals along the lane-to-shoulder joint.
- If heave of the shoulder occurs (upward movement), rate as a negative (-) value.



10. Lane-to-Shoulder Separation

Description

Widening of the joint between the traffic lane and the shoulder.

Severity Levels

Not applicable. However, severity levels can be defined in relation to inches of lane-to-shoulder separation as measured below.

How to Measure

In inches to the nearest 1/10" inch at 100' intervals along the lane-to-shoulder joint.



11. Patch/Patch Deterioration

Description

Portion of the original concrete slab that has been removed and replaced.

Severity Levels

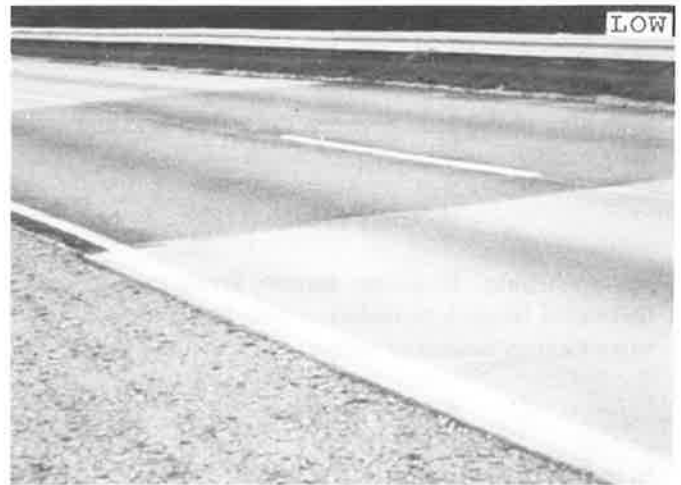
Low - Patch is in very good condition or has low severity distress of any type; faulting or settlement less than 1/4".

Moderate - Patch has moderate severity distress of any type; faulting or settlement 1/4" to 1/2".

High - Patch has high severity distress of any type; faulting or settlement greater than 1/2".

How to Measure

Square feet of surface area and number of patches at each severity level by material type—rigid vs. flexible.



12. Punchouts

Description

- The area enclosed by two closely spaced transverse cracks, a short longitudinal crack, and the edge of the pavement.
- As cracks deteriorate, aggregate interlock is lost, leading to steel rupture and allowing the concrete within these cracks to be punched downward under load.

Severity Levels

Low - Longitudinal and transverse cracks are fairly tight; low severity spalling or faulting less than 1/4" exists.

Moderate - Moderate spalling or faulting 1/4" to 1/2" exists.

High - Concrete within the punchout is punched down by more than 1/2" inch; may be leveled with asphalt.

How to Measure

- Number of punchouts at each severity level.
- The cracks which "outline" the punchout are also rated under "Transverse Cracking" and "Longitudinal Cracking."



CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

13. Spalling of Longitudinal Joints

Description

Cracking, breaking, chipping, or fraying of slab edges within 2' of the longitudinal (lane-to-lane) joint.

Severity Levels

Low - Less than 3" wide spalls.

Moderate - 3" to 6" wide spalls.

High - Greater than 6" wide spalls.

How to Measure

Linear feet at each severity level.



14. Water Bleeding and Pumping

Description

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

Severity Levels

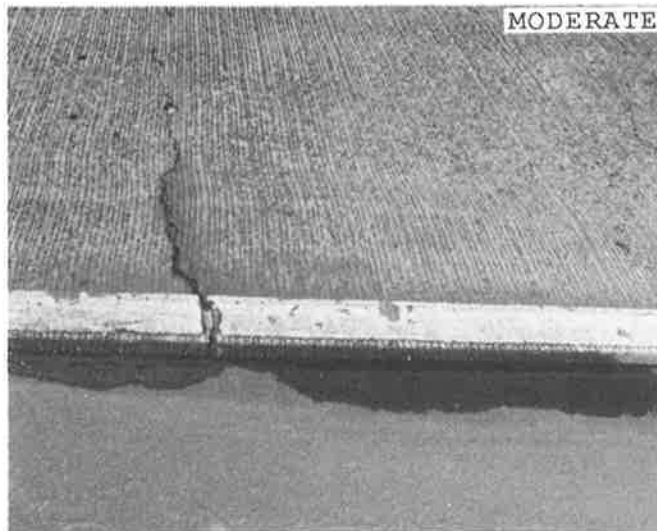
Low - Some water bleeding is present; no fines can be seen on the surface.

Moderate - Some pumped material (fines) exists near joints or cracks; small semi-circular (6" to 12" in radii) depressions may begin to form in AC shoulders adjacent to the pumping joints or cracks.

High - A significant amount of pumped material (fines) exists near joints or cracks; depressions in AC shoulders may exist with some patching.

How to Measure

Number and linear feet of effected joints and cracks at each severity level.



Glossary

Adhesive Failure—	loss of bond (i.e. between joint sealant & joint reservoir; between aggregate & binder)
Aggregate Interlock—	interaction of aggregate particles across cracks and joints to transfer load
Alligator Cracking—	a series of small, jagged, interconnecting cracks caused by failure of the asphalt concrete surface under repeated traffic loading
Approach Slab—	section of pavement just prior to joint, crack, or other significant roadway feature relative to the direction of traffic
(Asphalt) 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
Block Cracking—	the occurrence of cracks that divide the asphalt surface into approximately rectangular pieces, typically one square foot or more in size
Blowup—	the result of localized upward movement or shattering of a slab along a transverse joint or crack
Centerline—	the yellow line separating traffic traveling in opposite directions
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 diagonal crack forming between 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
Edge Cracking—	fracture along the pavement perimeter from soil movement beneath the pavement
Extrusion—	to be forced out (i.e. joint sealant from joint)
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
Joint Seal Damage—	any distress associated with the joint sealant, or lack of joint sealant
Lane Line—	boundary between travel lanes
Lane/Shoulder Dropoff—	the difference in elevation between the traffic lane and shoulder
Lane/Shoulder Separation—	widening of the joint between the traffic lane and the shoulder
Leave Slab—	section of pavement just past joint, crack, or other significant roadway feature relative to the direction of traffic
Longitudinal—	parallel to the centerline of the pavement or laydown direction
Map Cracking—	a series of interconnected hairline cracks that extend only into the upper surface of a concrete slab
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, which is now glossy in appearance and smooth to the touch
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 under pressure through cracks under moving loads
Punchout—	a localized area of the slab that is broken into pieces. Aggregate interlock 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

GLOSSARY

Reflection Cracking—	the fracture of asphalt concrete above cracks or joint, in the underlying pavement layer(s)
Rutting—	the occurrence of longitudinal surface depressions in the wheel paths
Scaling—	the deterioration of the upper 1/8" to 1/2" 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—	chipping of the slab surface within 2' of a joint or crack
Transverse—	perpendicular to the pavement centerline or direction of laydown
Water Bleeding—	seepage of water from joints or cracks
Weathering—	the wearing away of the pavement surface caused by the loss of asphalt binder

Index

ASPHALT CONCRETE PAVEMENTS

Alligator Cracking	5	Polished Aggregate	19
Bleeding	18	Pothole	13
Block Cracking	6	Raveling and Weathering	20
Edge Cracking	7	Reflective Cracking at Joints	9
Lane-to-Shoulder Dropoff	22	Rutting	15
Lane-to-Shoulder Separation	23	Shoving	16
Longitudinal Cracking	8	Transverse Cracking	10
Patch/Patch Deterioration	12	Water Bleeding & Pumping	24

JOINTED CONCRETE PAVEMENTS

Blowup	41	Map Cracking & Scaling	37
Corner Break	28	Patch/Patch Deterioration	45
Durability "D" Cracking	29	Polished Aggregate	38
Faulting of Transverse Joints & Cracks	42	Popout	39
Joint Seal Damage of Transverse Joints	33	Spalling of Longitudinal Joint	34
Lane-to-Shoulder Dropoff	43	Spalling of Transverse Joints	35
Lane-to-Shoulder Separation	44	Transverse Cracking	31
Longitudinal Cracking	30	Water Bleeding & Pumping	46

CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

Blowup	58	Patch/Patch Deterioration	62
Construction Joint Deterioration	59	Polished Aggregate	55
Durability "D" Cracking	50	Popout	56
Lane-to-Shoulder Dropoff	60	Punchout	63
Lane-to-Shoulder Separation	61	Spalling of Longitudinal Joint	64
Longitudinal Cracking	51	Transverse Cracking	52
Map Cracking & Scaling	54	Water Bleeding & Pumping	65

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Appendix

Strategic Highway Research Program

STATE PARTICIPATION SYNOPSIS

PROGRAM: SHRP LTPP INFORMATION MANAGEMENT SYSTEM

PROJECT: PAVEMENT PERFORMANCE DATA BASE

WHAT IS NEEDED: *SHRP needs State Highway agencies to set up pavement performance information management systems. SHRP, through a contract with Science Applications International Corporation, has developed the software to store and retrieve long-term pavement performance data.*

The SHRP Information Management System (IMS) is useful to states as a convenient and well-planned data storage system. This system will provide the user with reports in various forms.

These data summaries can be used to evaluate existing design methods, calibrate existing design methods, develop improved design methods, develop rehabilitation strategies and design methods, determine the effects of various explanatory variables on pavement performance, and quantify the effects of specific design features.

The LTPP IMS stores data in seven modules:

- a. Climate conditions that affect pavement performance*
- b. Inventory information to describe the site and the pavement layers*
- c. Laboratory testing results*
- d. Information on the cost of and types of maintenance performed*
- e. Monitoring data over the service life including:*
 - 1. Falling Weight Deflectometer*
 - 2. Profilometer*
 - 3. Distress surveys, manual or automated*
 - 4. Skid resistance*
- f. Descriptions of major rehabilitation*
- g. Historical and monitored data on traffic volumes, vehicle classifications, and axle loadings.*

Each of the seven modules is composed of a number of tables to represent a collection of information about a certain item. Each table in turn is a collection of records that contains data about a specific highway section. Each record is made up of fields that represent the smallest piece of information collected in the data base.

The SHRP section ID and the state code fields uniquely identify a selected pavement section and are the primary keys throughout the LTPP IMS. These fields may be modified by the user to meet individual user needs.

SELECTION CRITERIA: *In order to implement the IMS, the user agency should include in the plans to build a pavement performance data base: (1) the types of data to be included; and (2) the data collection plans for inventory, surface distress, profile, traffic, laboratory materials testing, deflection, skid resistance, environment, maintenance, and rehabilitation.*

COMPONENTS: *In addition to the data collection plans, a state should be prepared to spend in the range of \$10,000 to \$20,000 for the required computer hardware and software. The SHRP Regional Information Management Systems (RIMS) reside on a 386-class, IBM compatible PC running version 3.3 of DOS. Version 5.1B of PC ORACLE is used to manage the RIMS. Application software is written using Microsoft C and the ORACLE products SQL*Plus, SQL*Forms, SQL*Report, SQL*ReportWriter and PRO*C. The RIMS hardware consists of a COMPAQ 386/25 with the following configuration: 300-MB hard disc; 5-1/4-inch, 1.2-MB, high-density disc drive; parallel port; serial port; 3-1/2-inch, 1.44-MB, high-density disc drive; 4-MB RAM; 125-MB external cartridge tape drive; enhanced color display adapter; color display; tractor feed printer with 32K RAM*

buffer; and a 2400-baud modem. This hardware costs about \$10,000. An optional optical disc drive for long-term storage costs approximately \$6,000.

For data base sections it will be advantageous to know the existing pavement structure, materials, and traffic history. As a minimum, plans should be prepared to monitor traffic, surface distress and profile with time. Laboratory resilient modulus testing equipment and a deflection device also are recommended.

TIME FRAME: *The IMS is currently operational and in use.*

ESTIMATED RESOURCES: *The cost of computer hardware and software is estimated at \$10,000 to \$20,000. The personnel requirements will depend on the number of sections in the agency's data base and the extent of the data collection. For example, to store data on all pavements in an agency, a full-time data base manager could be required. Continuous deflection testing, profilometer and distress surveys would require at least two others. Materials testing could probably be incorporated in existing laboratory facilities.*

CONTACT: *For additional information, contact Shahed Rowshan at 202/334-1441.*

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