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PAVEMENT CONDITION RATING SYSTEM

REVIEW OF PCR METHODOLOGY

Report No. FHWA/OH-99/004

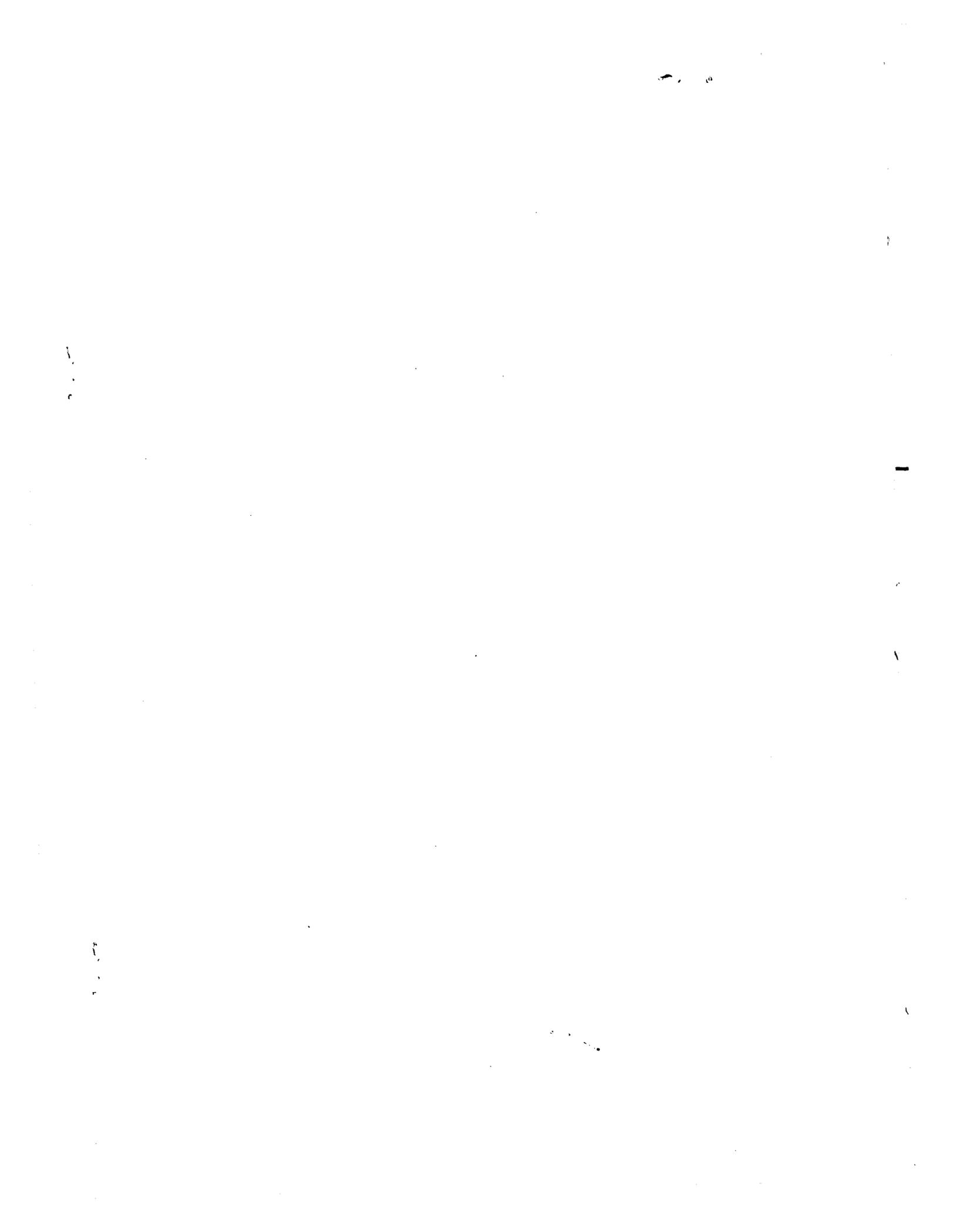


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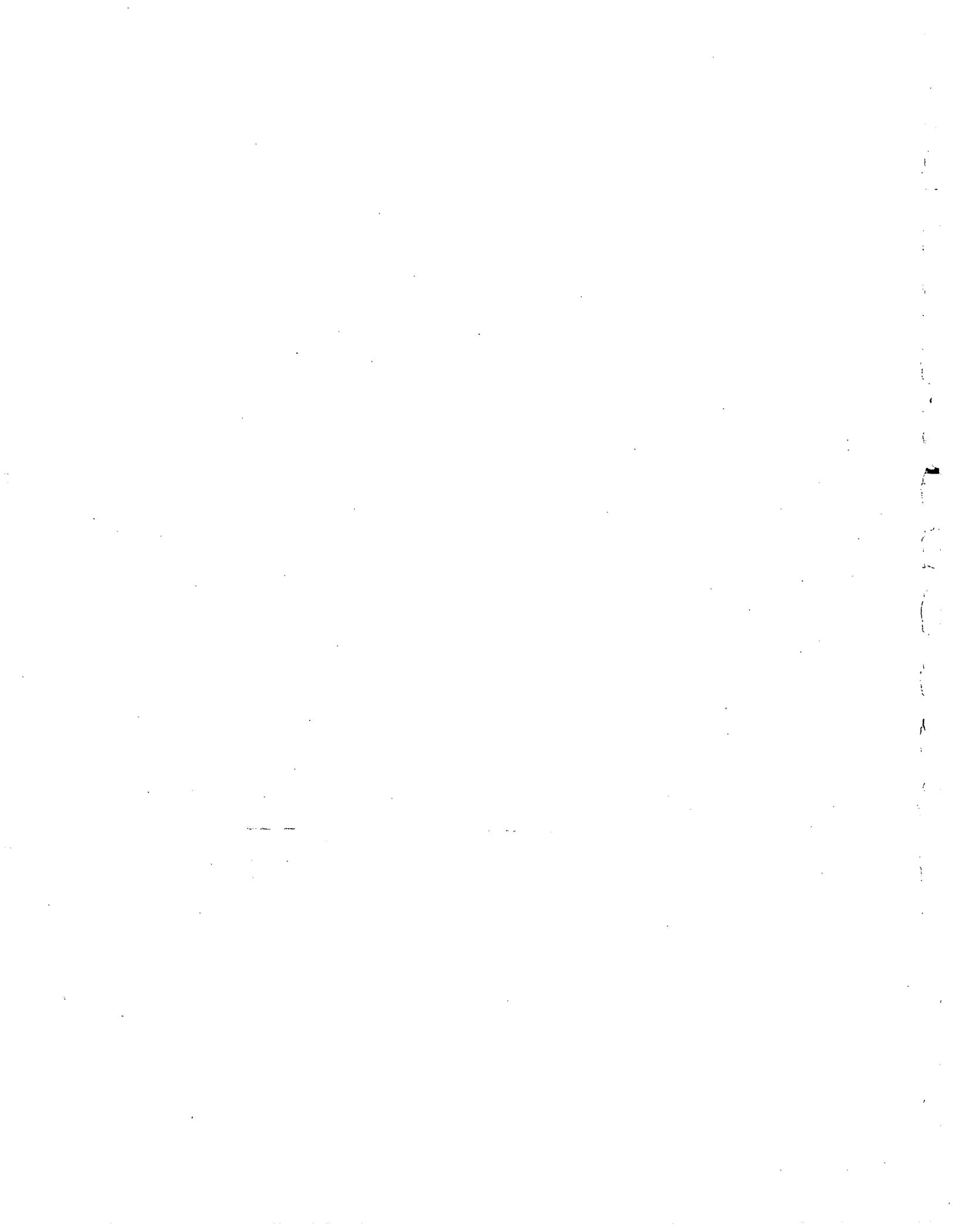


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March, 1998



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16. Abstract <p>This report describes the Pavement Condition Rating method which was developed for the State of Ohio Highway Network. The method is based upon visual inspection of pavement distresses. Although the relationship between pavement distresses and performance is not well defined, there is general agreement that the ability of a pavement to sustain traffic loads in a safe and smooth manner is adversely affected by the occurrence of observable distress. The rating method described in this report provides a procedure for uniformly identifying and describing, in terms of severity and extent, pavement distress. The mathematical expression for pavement condition rating (PCR) provides an index reflecting the composite effects of various distress types, their severity and extent upon the overall condition of the pavement.</p> <p>Distresses of four (4) types of Pavements (Flexible, Composite, Jointed Concrete and Continuously Reinforced or CRC) are described in this report and each distress is illustrated with the help of photographs.</p> <p style="text-align: center;">OHIO DEPT. OF TRANSPORTATION LIBRARY 1930 W. BROAD STREET COLUMBUS, OH 43223</p>		
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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Ohio Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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The revision of this manual was performed under the project "A Review of PCR Methodology for the Ohio DOT," State Job Number 14638(0). This report is made possible through the help and support received from the Ohio Department of Transportation staff, Messrs. Roger Green, Kenneth Corns, Andrew Williams, Aric Morse, Dave Miller, and Murphy Hsu. Most of the photographs have been revised and the original photographs are in color now. The sources of these photographs are listed in Appendix E.

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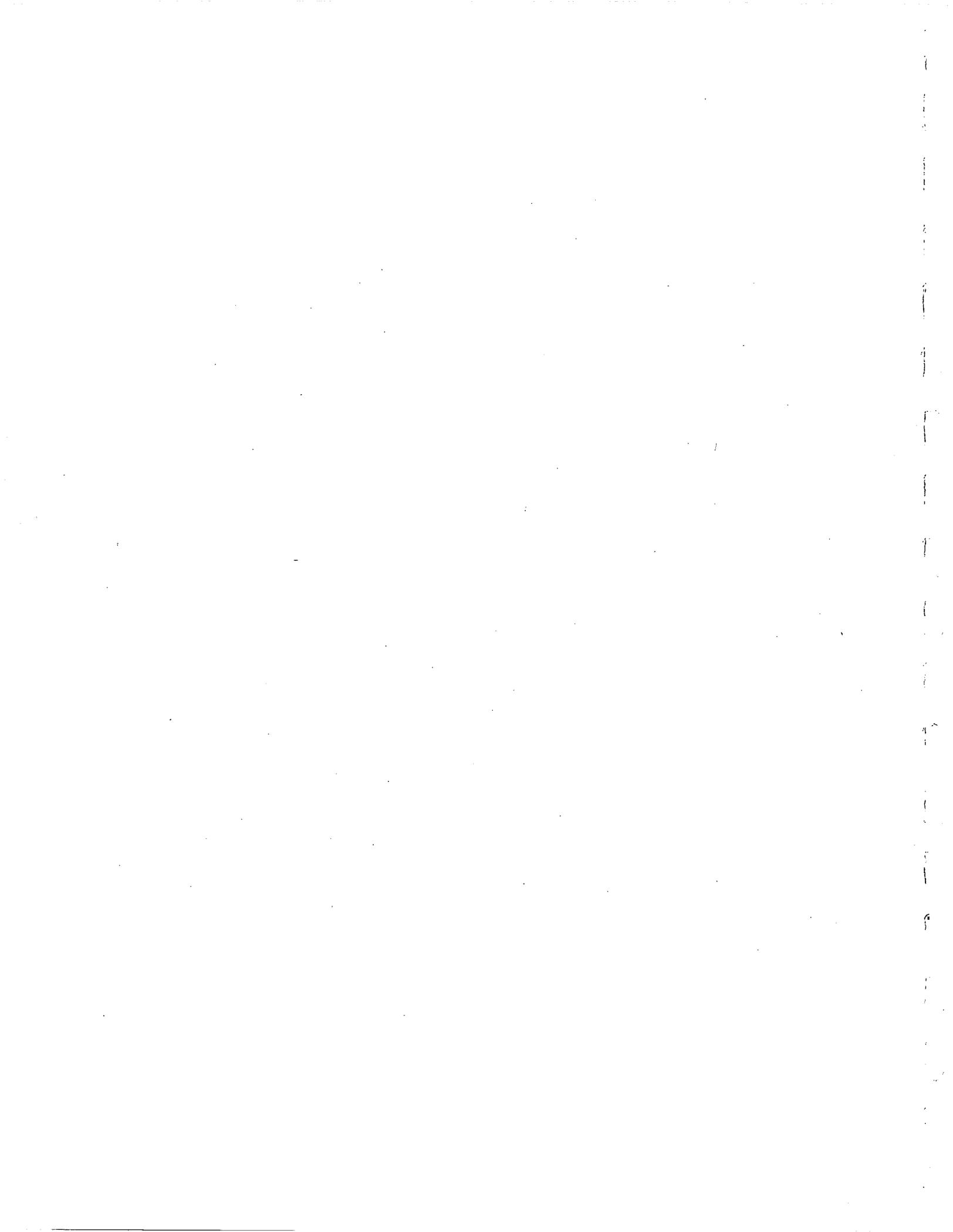
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PAVEMENT CONDITION RATING PROCEDURES

INTRODUCTION

The rating method is based upon visual inspection of pavement distress. Although the relationship between pavement distress and performance is not well defined, there is general agreement that the ability of a pavement to sustain traffic loads in a safe and smooth manner is adversely affected by the occurrence of observable distress. The rating method provides a procedure for uniformly identifying and describing, in terms of severity and extent, pavement distress. The mathematical expression for pavement condition rating (PCR) provides an index reflecting the composite effects of varying distress types, severity, and extent upon the overall condition of the pavement.

The model for computing PCR is based upon the summation of deduct points for each type of observable distress. Deduct values are a function of distress type, severity, and extent. Deduction for each distress type is calculated by multiplying distress weight times the weights for severity and extent of the distress. Distress weight is the maximum number of deductible points for each different distress type. The mathematical expression for PCR is as follows:

$$PCR = 100 - \sum_{I=1}^n \text{Deduct}_I \quad (1)$$

Where:

n = number of observable distresses, and

Deduct = (Weight for distress) (Wt. for severity) (Wt. for Extent)

The Appendices A-D that follow describe various distresses for rigid, flexible, and composite pavements and current guidelines for establishing their severity and extent. Three levels of severity (Low, Medium and High) and three levels of extent (Occasional, Frequent, and Extensive) are defined. The definition for distress type, severity, and extent must be followed closely and be clearly understood by field personnel if the rating method is to provide meaningful data. To illustrate the method for calculating PCR, consider the distress "Faulting" in a hypothetical jointed concrete pavement. If the severity of this distress in the pavement is "Medium" and extent is "Frequent", then, the deduct points for "Faulting" in the pavement would be equal to [(10) (0.7) (0.8)] or 5.6 (see Table on page 11 for the weights of this distress). If an extensive amount of medium severity "Surface Deterioration" is also observed the deduct points for this distress would be equal to [(10) (0.7) (1)] or 7.0. The PCR for the pavement based upon these 2 distresses would equal to:

$$PCR = 100 - (5.6 + 7.0) = 87.4 \quad (2)$$

The deduct weights for each pavement type have been developed on the basis of the review of the rating methods developed in the United States, Europe, and Canada and the experience gained from the rating methods developed by the Resource staff as a result of studies conducted in this connection. Two premises were considered when assigning the weights:

1. Overlaying and/or rehabilitation of high type (multi-lane) roadways should be considered when the PCR drops within the range of 65 to 55.
2. Deteriorated pavements normally exhibit several different types of distress. Rarely is only a single type of distress observed for a particular pavement.

The first premise is useful in establishing a target value for the proper PCR of pavements that are in a certain state or condition. Roadways scheduled for rehabilitation and resurfacing have to be rated by the PCR procedure.

A Pavement Condition Rating (PCR) Scale was developed to describe the pavement condition using the PCR numbers calculated from Equation (1). This scale has a range from 0 to 100; a PCR of 100 represents a perfect pavement with no observable distress and a PCR of 0 represents a pavement with all distress present at their "High" levels of severity and "Extensive" levels of extent. Figure 1 illustrates the PCR Scale and the descriptive condition of a pavement associated with the various ranges of the PCR values.

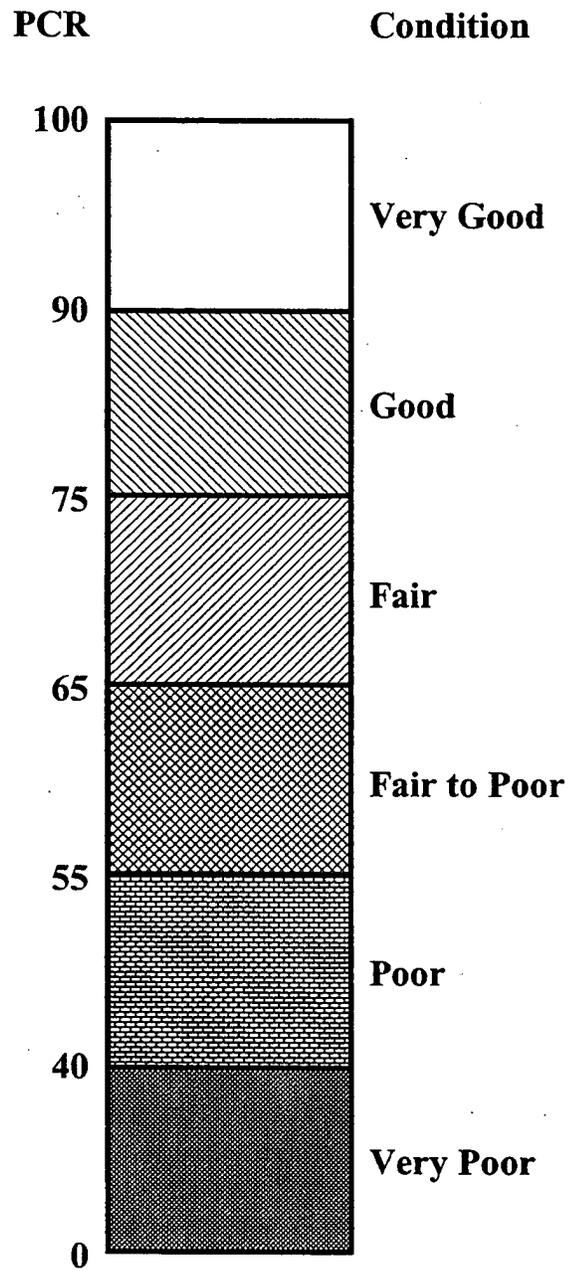


Figure 1. Pavement Condition Rating (PCR) Scale

Section: _____

KEY

Date: _____

Log Mile: _____ to _____

FLEXIBLE PAVEMENT CONDITION

Rated by: _____

Sta: _____ to _____

RATING FORM

DISTRESS	Distress Weight	SEVERITY*			EXTENT**			STR ***
		L	M	H	O	F	E	
RAVELING	10	Slight Loss of Sand	Open Texture	Rough or pitted	<20%	20-50%	>50%	
BLEEDING	5	not rated	Bit and Agg visible	Black Surface	<10%	10-30%	>30%	
PATCHING	5	<1 ft ²	<1 yd ²	>1 yd ²	<10/mile	10-20/mile	>20/mile	
POTHLES/DEBONDING	10	depth <1" area <1 yd ²	<1" >1 yd ² >1" <1 yd ²	>1" and >1 yd ²	<5/mile	5-10/mile	>10/mile	✓
CRACK SEALING DEFIC.	5		Not considered		<20%	20-50%	>50%	
RUTTING	10	<1/4"	1/4-1"	>1"	<20%	20-50%	>50%	✓
SETTLEMENTS	10	Noticeable effect on ride	Some Discomfort	Poor Ride	<2/mi	2-4/mi	>4/mi	
CORRUGATIONS	5	Noticeable effect on ride	Some Discomfort	Poor Ride	<10%	10-30%	>30%	
WHEEL TRACK CRACKING	15	Single/multiple cracks <1/4"	Multiple cracks >1/4"	Alligator >1/4" Spalling	<20%	20-50%	>50%	✓
BLOCK & TRANSVERSE CRACKING	10	<1/4" wide, no Spalling	1/4-1" along min .5 length	>1" along min .5 length	<20%	20-50%	>50%	✓
LONGITUDINAL JOINT CRACKING	5	Single, <1/4", no Spalling	single/multiple 1/4-1", some Spalling	Multiple, >1", Spalling	<50' per 100'	50-100' per 100'	>150' per 100'	
EDGE CRACKING	5	Tight, <1/4"	>1/4", some Spalling	>1/4", moderate Spalling	<20%	20-50%	>50%	
RANDOM CRACKING	5	<1/4"	1/4-1"	>1"	<20%	20-50%	>50%	✓

*L = LOW
 M = MEDIUM
 H = HIGH
 **O = OCCASIONAL
 F = FREQUENT
 E = EXTENSIVE

***STR = DISTRESS INCLUDED IN STRUCTURAL DEDUCT CALCULATIONS.

Section: _____

Log mile: _____ to _____

Sta: _____ to _____

Date: _____

Rated by: _____

L X I L

PAVE E T C I T I A T I F O

DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
RAVELING	10	.3	.6	1	.5	.8	1	
BLEEDING	5	.8	.8	1	.6	.9	1	
PATCHING	5	.3	.6	1	.6	.8	1	
POTHoles/DEBONDING	10	.4	.7	1	.5	.8	1✓	
CRACK SEALING DEFICIENCY	5	1	1	1	.5	.8	1	
RUTTING	10	.3	.7	1	.6	.8	1✓	
SETTLEMENT	10	.5	.7	1	.5	.8	1	
CORRUGATIONS	5	.4	.8	1	.5	.8	1	
WHEEL TRACK CRACKING	15	.4	.7	1	.5	.7	1✓	
BLOCK AND TRANSVERSE CRACKING	10	.4	.7	1	.5	.7	1✓	
LONGITUDINAL JOINT CRACKING	5	.4	.7	1	.5	.7	1	
EDGE CRACKING	5	.4	.7	1	.5	.7	1	
RANDOM CRACKING	5	.4	.7	1	.5	.7	1✓	

*L = LOW **O = OCCASIONAL

M = MEDIUM F = FREQUENT

H = HIGH E = EXTENSIVE

*** DEDUCT POINTS = DISTRESS WEIGHT X SEVERITY WT. X EXTENT WT.

REMARKS:

TOTAL DEDUCT =

SUM OF STRUCTURAL DEDUCT (✓) =

100 - TOTAL DEDUCT = PCR =

Section: _____

KEY

Date: _____

Log Mile: _____ to _____

COMPOSITE PAVEMENT CONDITION

Rated by: _____

Sta: _____ to _____

RATING FORM

DISTRESS	Distress Weight	SEVERITY*			EXTENT**			STR ***
		L	M	H	O	F	E	
RAVELING	10	Slight Loss of Sand	Open Texture	Rough or Pitted	<20%	20-50%	>50%	
BLEEDING	5	not rated	Bitumen & Agg. Visible	Black Surface	<10%	10-30%	>30%	
PATCHING	5	<1 ft ²	<1 yd ²	>1 yd ²	<10/mile	10-20/mile	>20/mile	
SURFACE DISINTEGRATION/DEBONDING	5	depth <1" area <1 yd ²	<1", >1 yd ² >1", <1 yd ²	>1" and >1 yd ²	<5/mile	5-10/mile	>10/mile	
RUTTING	10	<1/4"	1/4-1"	>1"	<20%	20-50%	>50%	
PUMPING	15	Slight Staining			excessive staining, fault	<10%	>25%	✓
SHATTERED SLAB	10	Little Spall, No Faults	Some Spall. Moderate Faults	Severe Distortion, Poor Ride	<2/mi	2-5/mi	>5/mi	✓
SETTLEMENTS	5	Noticeable effect on ride	Some Discomfort	Poor Ride	<2/mi	2-4/mi	>4/mi	
TRANSVERSE CRACKS, UNJOINTED BASE	20	<1/4", no spalling	1/4 - 1", >.5 spalled	>1", >.5 spalled	CS>15'	10'<CS<15'	CS<10'	✓
JOINT REFLECTION CRACKS, JOINTED BASE	12	<1/4", no spalling	1/4 - 1", >.5 spalled	>1", >.5 spalled	<20%	20-50%	>50%	✓
INTERMEDIATE TRANSVERSE CRACKS, JOINTED BASE	8	<1/4", no spalling	1/4 - 1", >.5 spalled	>1", >.5 spalled	CS>15'	10'<CS<15'	CS<10'	✓
Longitudinal Cracking	5	<1/4", no spalling	1/4 - 1", >.5 spalled	>1", >.5 spalled	<50' per 100'	50 - 150' per 100'	>150' per 100'	✓
Pressure Damage/ Upheaval	5	bump <1/2", Good Ride	1/2-1", Fair Ride	>1", Poor Ride	<20%	20-50%	>50%	
Crack Sealing deficiency	5	Not considered			<20%	20-50%	>50%	

*L = LOW
 M = MEDIUM
 H = HIGH
 **O = OCCASIONAL
 F = FREQUENT
 E = EXTENSIVE
 ***STR = DISTRESS INCLUDED IN STRUCTURAL DEDUCT CALCULATIONS.

ctio :

Log mile: _____ to _____

Sta: _____ to _____

C

IT

PAVE T C ITI ATI F

Rated by: _____

DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
RAVELING	10	.3	.6	1	.5	.8	1	
BLEEDING	5	.8	.8	1	.6	.9	1	
PATCHING	5	.3	.6	1	.6	.8	1	
SURFACE DISINTEGRATION or DEBONDING	5	.3	.6	1	.6	.8	1	
RUTTING	10	.3	.7	1	.6	.8	1	
PUMPING	15	.7	.7	1	.3	.7	1✓	
SHATTERED SLAB	10	.6	.8	1	.7	.9	1✓	
SETTLEMENTS	5	.4	.7	1	.6	.8	1	
TRANSVERSE CRACKS, UNJOINTED BASE	20	.2	.6	1	.4	.8	1✓	
JOINT REFLECTION CRACKS, JOINTED BASE	12	.2	.6	1	.4	.8	1✓	
INTERMEDIATE TRANSVERSE CRACKS, JOINTED BASE	8	.2	.6	1	.4	.8	1✓	
LONGITUDINAL CRACKING	5	.2	.6	1	.4	.8	1✓	
PRESSURE DAMAGE/UPHEAVAL	5	.4	.6	1	.5	.8	1	
CRACK SEALING DEFICIENCY	5	1	1	1	.5	.8	1	
TOTAL DEDUCT =								
SUM OF STRUCTURAL DEDUCT (✓) =								
100 - TOTAL DEDUCT = PCR =								

*L = LOW **O = OCCASIONAL

M = MEDIUM F = FREQUENT

H = HIGH E = EXTENSIVE

*** DEDUCT POINTS = DISTRESS WEIGHT X SEVERITY WT. X EXTENT WT.

REMARKS:

Section:

KEY

Date:

Log Mile: _____ to _____

JOINTED CONCRETE PAVEMENT

Rated by:

Sta: _____ to _____

CONDITION RATING FORM

DISTRESS	Distress Weight	SEVERITY WEIGHT*			EXTENT WEIGHT**			STR ***
		L	M	H	O	F	E	
SURFACE DETERIORATION	10	Aggregate visible	Loss of fine aggregate	Surface rough or pitted	<20%	20-50%	>50%	
POPOUTS	5	Not considered			<20%	20-50%	>50%	
PATCHING	5	<1 ft ² , no deterioration.	<1 ft ² , deterioration.	>1 ft ²	<10/mi	10-20/mi	>20/mi	✓
PUMPING	15	some staining, rater is certain of pumping			<10%	10-25%	>25%	✓
FAULTING (Joints & Cracks)	10	<1/4"	1/4-1/2"	>1/2"	<20%	20-50%	>50%	
SETTLEMENTS	5	Noticeable effect on Ride	Some discomfort	Poor Ride	2/mi.	2-4/mi.	>4/mi.	
TRANSVERSE JOINT SPALLING	15	<4" wide	4-9" wide	>9" wide	<25%	25-75%	75%	
JOINT SEALANT DAMAGE	5	Not considered			<20%	20-50%	50%	
PRESSURE DAMAGE	5	Not considered			<1/mi	1-3/mi	>3/mi	
TRANSVERSE CRACKING	10	Hairline	1/4-1"	>1"	CS>15'	10<CS<15'	CS<10'	✓
LONGITUDINAL CRACKING	5	Hairline	1/4-1"	>1"	<5%	5-20%	>20%	✓
CORNER BREAKS	10	<1/4"	1/4-1"	>1"	3/mi	4-10/mi.	>10 mi.	✓

*L = LOW
 M = MEDIUM
 H = HIGH

**O = OCCASIONAL
 F = FREQUENT
 E = EXTENSIVE

***STR = DISTRESS INCLUDED IN STRUCTURAL DEDUCT CALCULATIONS.

Section:

Log mile: _____ to _____

Sta: _____ to _____

Date:

Rated by:

JOI T CO C T

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DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
SURFACE DETERIORATION	10	.4	.7	1	.6	.8	1	
POPOUT	5	1	1	1	.4	.6	1	
PATCHING	5	.4	.7	1	.5	.8	1	
PUMPING	15	.7	.7	1	.3	.7	1✓	
FAULTING (JOINTS AND CRACKS)	10	.4	.7	1	.5	.8	1✓	
SETTLEMENTS	5	.4	.7	1	.5	.8	1	
TRANSVERSE JOINT SPALLING (CIRCLE IF D-CRACKED)	15	.4	.7	1	.5	.8	1	
JOINT SEALANT DAMAGE	5	1	1	1	.5	.8	1	
PRESSURE DAMAGE	5	1	1	1	.5	.8	1	
TRANSVERSE CRACKING	10	.3	.8	1	.4	.8	1✓	
LONGITUDINAL CRACKING	5	.5	.7	1	.4	.9	1✓	
CORNER BREAKS	10	.4	.8	1	.5	.8	1✓	

*L = LOW **O = OCCASIONAL

M = MEDIUM F = FREQUENT

H = HIGH E = EXTENSIVE

*** DEDUCT POINTS = DISTRESS WEIGHT X SEVERITY WT. X EXTENT WT.

REMARKS:

TOTAL DEDUCT =

SUM OF STRUCTURAL DEDUCT (✓) =

100 - TOTAL DEDUCT = PCR =

Section:

KEY

Date:

Log Mile: _____ to _____

CRC PAVEMENT CONDITION

Rated by:

Sta: _____ to _____

RATING FORM

DISTRESS	DISTRESS WEIGHT	SEVERITY WEIGHT*			EXTENT WEIGHT**			STR ***
		L	M	H	O	F	E	
SURFACE DETERIORATION	10	Aggregate visible	Loss of fine aggregate	Surface rough or pitted	<20%	20-50%	>50%	
POPOUTS	5	Not considered			<20%	20-50%	>50%	
PATCHING	5	<1 ft ² , no deterioration	<1 ft ² , deterioration	>1 ft ²	<10/mi	10-20/mi	>20/mi	✓
PUMPING	15	some staining, rater is certain of pumping			<10%	10-25%	>25%	✓
SETTLEMENTS & WAVES	10	Noticeable effect on Ride	Some discomfort	Poor Ride	<2/mi. (<20%)	2-4/mi 20-50%	>4/mi (>50%)	✓
TRANSVERSE CRACK SPACING	10	CS 3-5'	CS <3'	CS <3' Many cracks intersect	<20%	20-50%	>50%	✓
LONGITUDINAL CRACKING	10	Hairline	>1/4" - 1"	>1"	<5%	5-15%	>15%	✓
PUNCHOUTS & EDGE BREAKS	15	Not rated	cracks <1/4" depress <1/2"	depress >1/2" Breaking up	<2/mi.	2-5/mi	>5/mi	✓
SPALLING	15	<1", few pieces missing	1 - 4" wide, most pieces missing	>4" wide, most pieces missing	<20%	20-50%	>50%	
PRESSURE DAMAGE	5	Not considered			<1/mi.	1 - 3/mi.	>3/mi.	

*L = LOW
M = MEDIUM
H = HIGH

***STR = DISTRESS INCLUDED IN STRUCTURAL DEDUCT CALCULATIONS.

**O = OCCASIONAL
F = FREQUENT
E = EXTENSIVE

Section:

C C

Date:

Log mile: _____ to _____

Rated by:

Sta: _____ to _____

PAV TC ITI ATI F

DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
SURFACE DETERIORATION	10	.4	.7	1	.5	.8	1	
POPOUT	5	1	1	1	.4	.6	1	
PATCHING	5	.4	.7	1	.5	.8	1✓	
PUMPING	15	.7	.7	1	.3	.7	1✓	
SETTLEMENTS & WAVES	10	.3	.7	1	.4	.7	1✓	
TRANSVERSE CRACK SPACING	10	.4	.7	1	.4	.8	1✓	
LONGITUDINAL CRACKING	10	.4	.8	1	.5	.8	1✓	
PUNCHOUTS OR EDGE BREAKS	15	.0	.8	1	.6	.9	1✓	
SPALLING	15	.3	.6	1	.5	.8	1	
PRESSURE DAMAGE	5	1	1	1	.7	.9	1	

*L = LOW **O = OCCASIONAL

M = MEDIUM F = FREQUENT

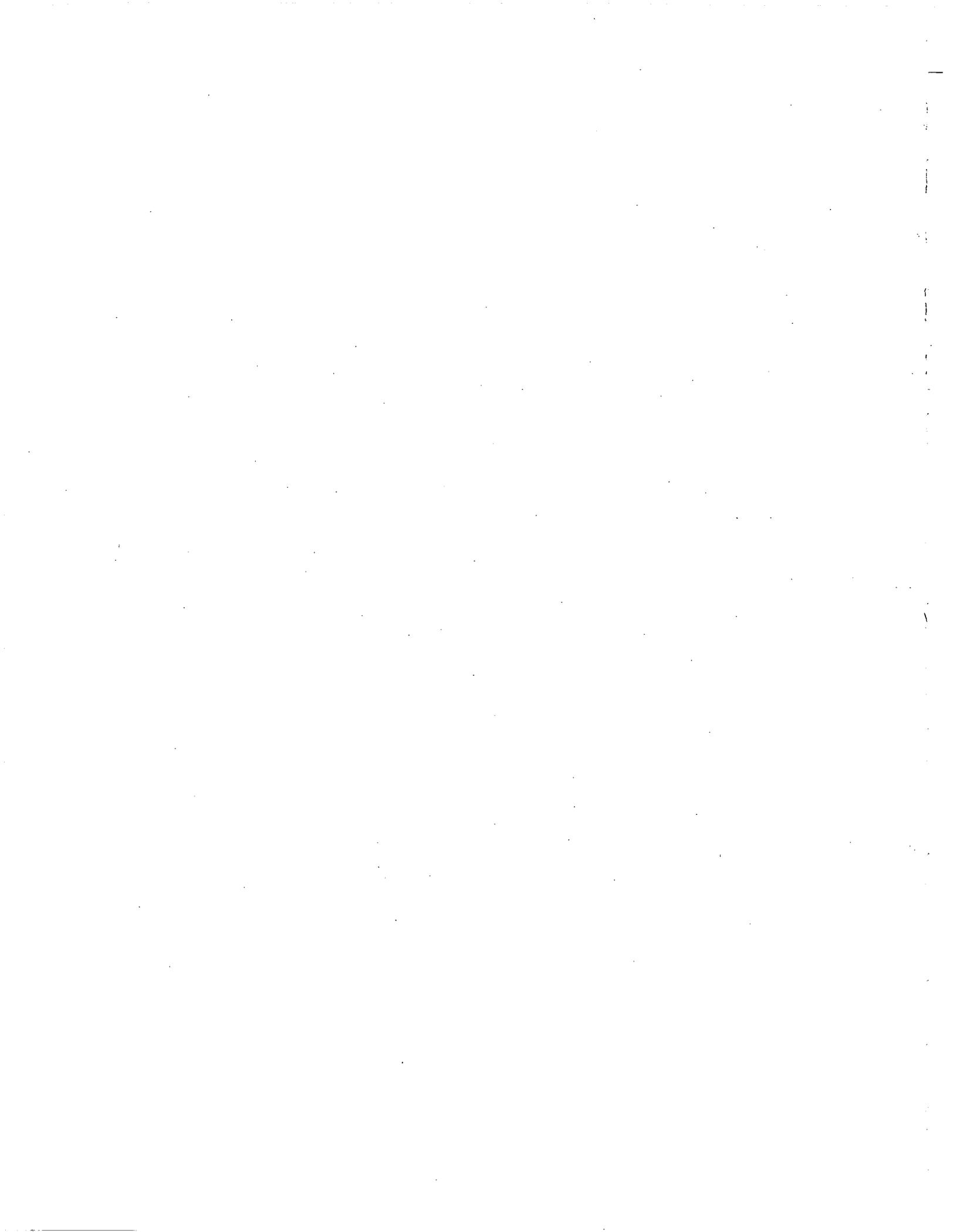
H = HIGH E = EXTENSIVE

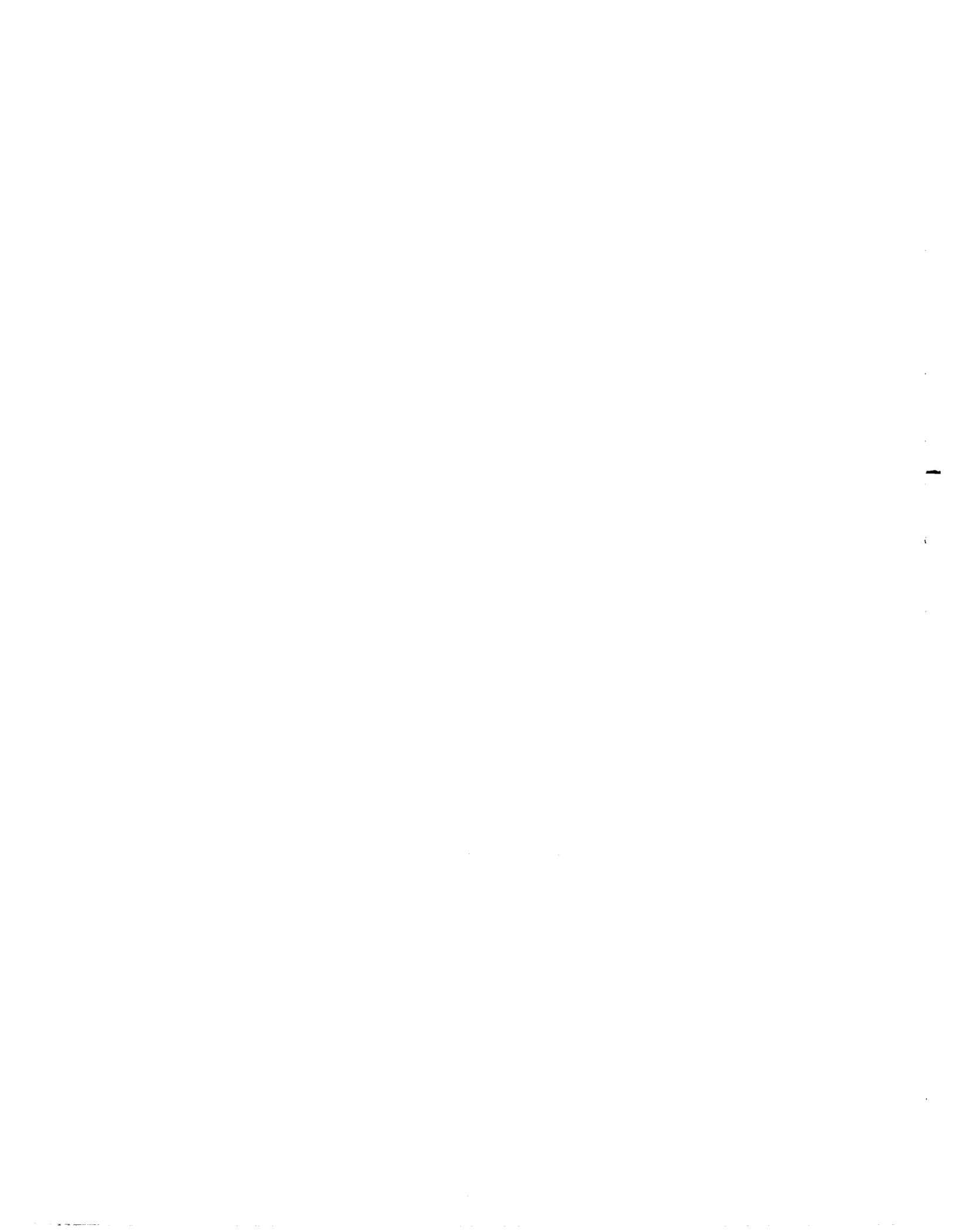
*** DEDUCT POINTS = DISTRESS WEIGHT X SEVERITY WT. X EXTENT WT.
REMARKS:

TOTAL DEDUCT =

SUM OF STRUCTURAL DEDUCT (✓) =

100 - TOTAL DEDUCT = PCR =





APPENDIX A

Description of Distresses in Flexible Pavements

FLEXIBLE PAVEMENT

Distress Type:	Raveling
Description:	Disintegration of the pavement from the surface downward due to the loss of aggregate particles. Raveling may occur as a result of asphalt binder aging, poor mixture quality, segregation, or insufficient compaction.
Severity Level:	Low-- Very little coarse aggregate has worn away. Loss of fine aggregate. Coarse aggregate exposed.
	Medium-- Surface has an open texture and is moderately rough with considerable loss of fine aggregate and some coarse aggregate removed.
	High-- Most of the surface aggregate has worn away or become dislodged. Surface is severely rough and pitted and may be completely removed in places.
Extent Level:	Occasional-- Less than 20 percent of the surface area is raveling.
	Frequent-- Between 20 and 50 percent of the surface area is raveling.
	Extensive-- More than 50 percent of the surface area is raveling.

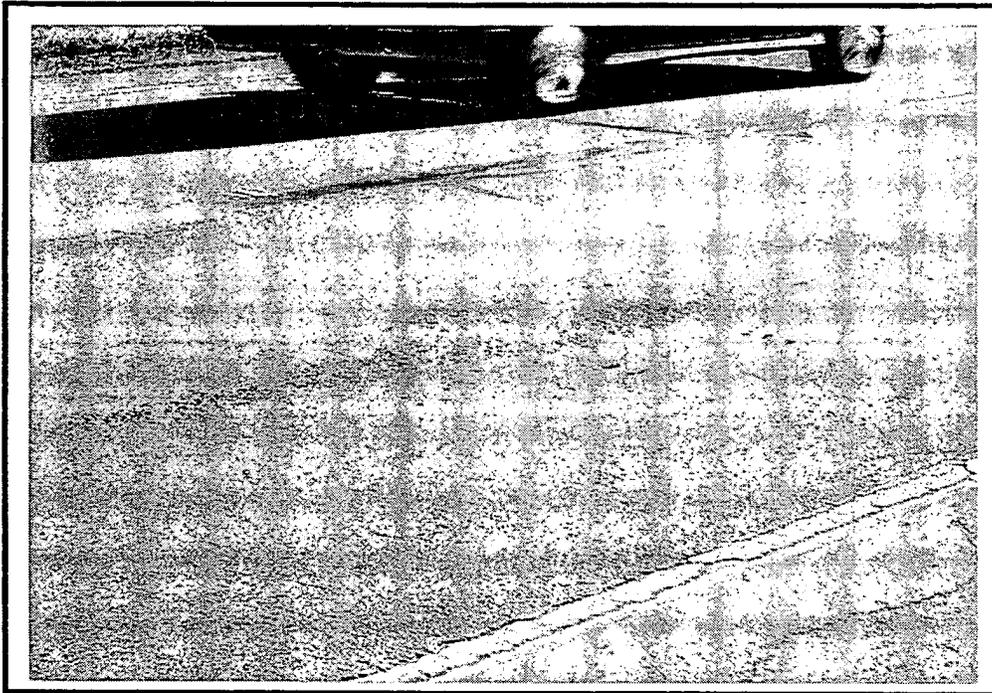


Photo A-1. Raveling in Flexible Pavement, Medium Severity



Photo A-2. Raveling in Flexible Pavement, High Severity

FLEXIBLE PAVEMENT

Distress Type:	Bleeding
Description:	Bleeding or flushing is the presence of free asphalt binder on the pavement surface. Bleeding is caused by an excess amount of bituminous binder in the mixture and/or low air void content.
Severity Level:	Only 2 severity levels are defined. Medium-- both coarse aggregate and free bitumen are noticeable at the pavement surface. High-- surface appears black with very little aggregate noticeable.
Extent Level:	Occasional-- less than 10 percent of the length exhibits bleeding. Frequent-- between 10 and 30 percent of the length is bleeding. Extensive-- bleeding occurs in more than 30 percent of the length.



Photo A-3. Bleeding in Flexible Pavement, High Severity

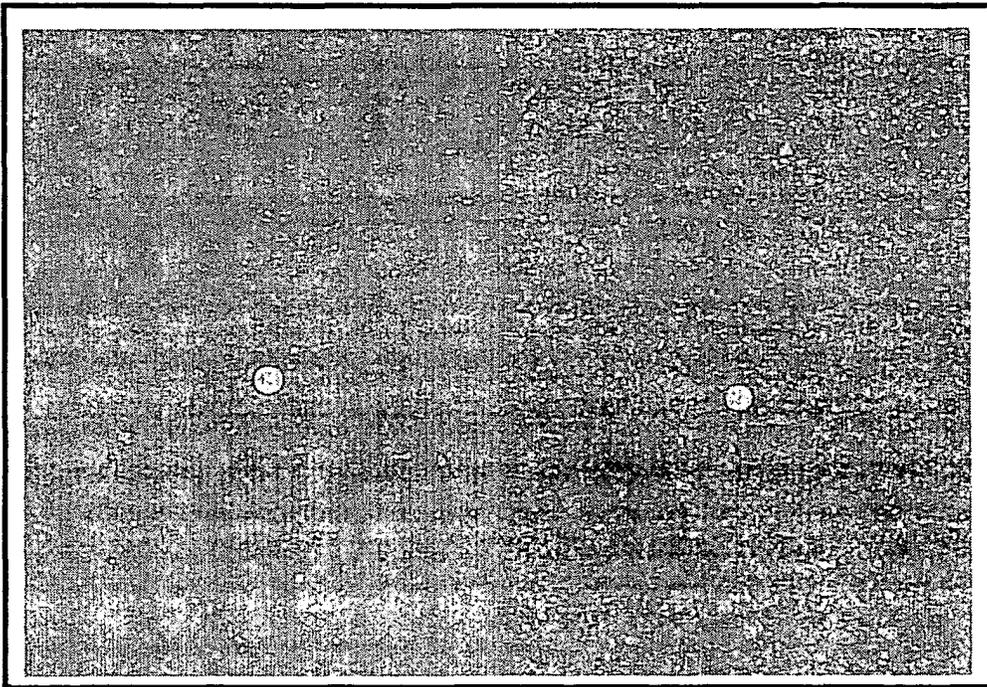


Photo A-4. Close-up view of Bleeding, High and Medium Severity
High Severity on left shows most aggregates covered with asphalt and Medium Severity on right shows less aggregates covered with asphalt

FLEXIBLE PAVEMENT

Distress Type: **Patching**

Description: Patching is either the placing of asphalt concrete on the surface of the existing pavement or the replacement of the existing pavement in small isolated areas.

Deductions shall be made for all patches present in the pavement which are the result of deterioration and/or maintenance since the last construction project.

Large patched areas [greater than 12.5 m² (15 sq. yd.)], such as spot overlays or wedge courses, shall be rated for condition as a part of the existing pavement rather than as patches.

Severity Level: **Low--** patch size < 0.1 m² (1 sq. ft.).

Medium-- patch size < 0.8 m² (1 sq. yd.).

High-- patch size > 0.8 m² (1 sq. yd.).

Extent Level: **Occasional--** < 10 patches/1.6 km (per mile).

Frequent-- 10 - 20 patches/1.6 km (per mile).

Extensive-- > 20 patches/1.6 km (per mile).



Photo A-5. Patching in Flexible Pavement, High Severity

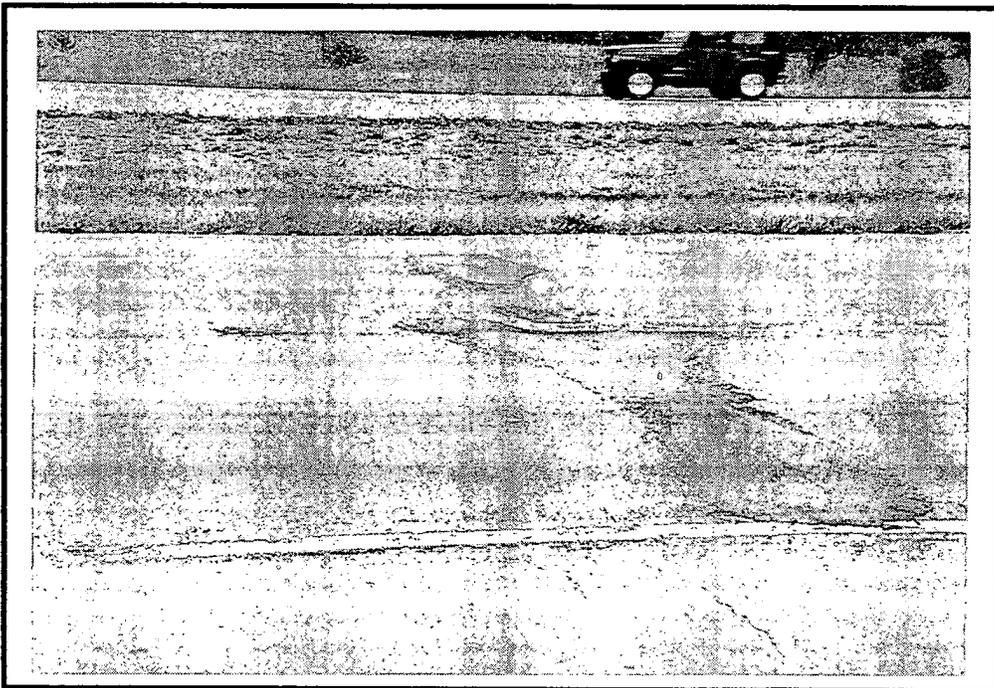


Photo A-6. Patching in Flexible Pavement, High Severity

FLEXIBLE PAVEMENT

Distress Type: **Potholes/Debonding**

Description: Potholes are bowl-shaped voids or depressions in the pavement surface. Potholes are localized failure areas which are usually caused by weak base or subgrade layers.

Loss of surface by debonding is the removal of the asphaltic surface layer from the underlying layer. The problem is most common with thin asphalt surface layers [less than 50 mm (2 inches)] and is caused by freeze-thaw action or poor bonding of the two layers during construction.

Severity Level: Use the following table to determine the severity levels:

Depth of Debonded Area	Debonded Area <0.8 m² (1 sq. yd.)	Debonded Area >0.8 m² (1 sq. yd.)
< 25 mm (1")	Low	Medium
> 25 mm (1")	Medium	High

Regardless of depth, potholes less than 150 mm (6 inches) in diameter shall be considered to be of low severity.

Extent Level: Occasional-- < 5 potholes/1.6 km (per mile).

Frequent-- 5 - 10 potholes/1.6 km (per mile).

Extensive-- > 10 potholes/1.6 km (per mile).

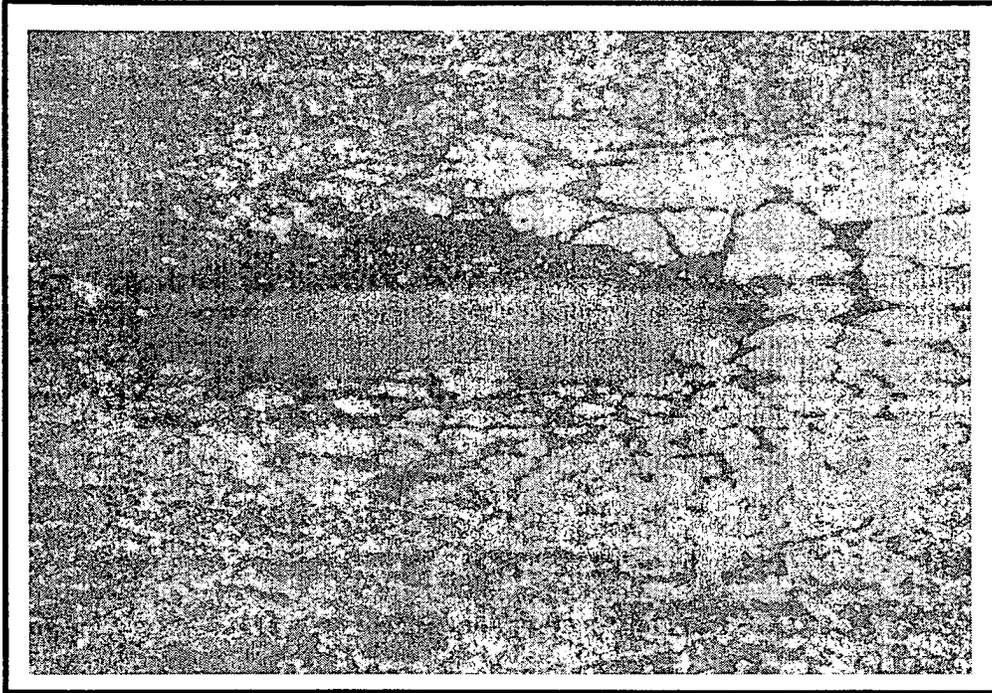


Photo A-7. Pothole in Flexible Pavement, Medium Severity

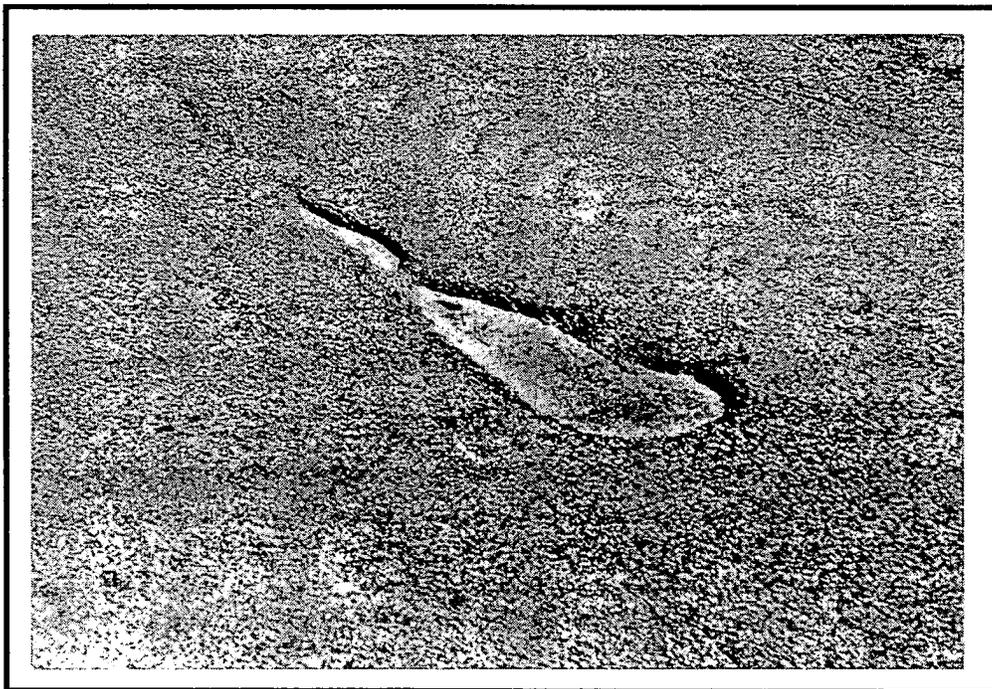
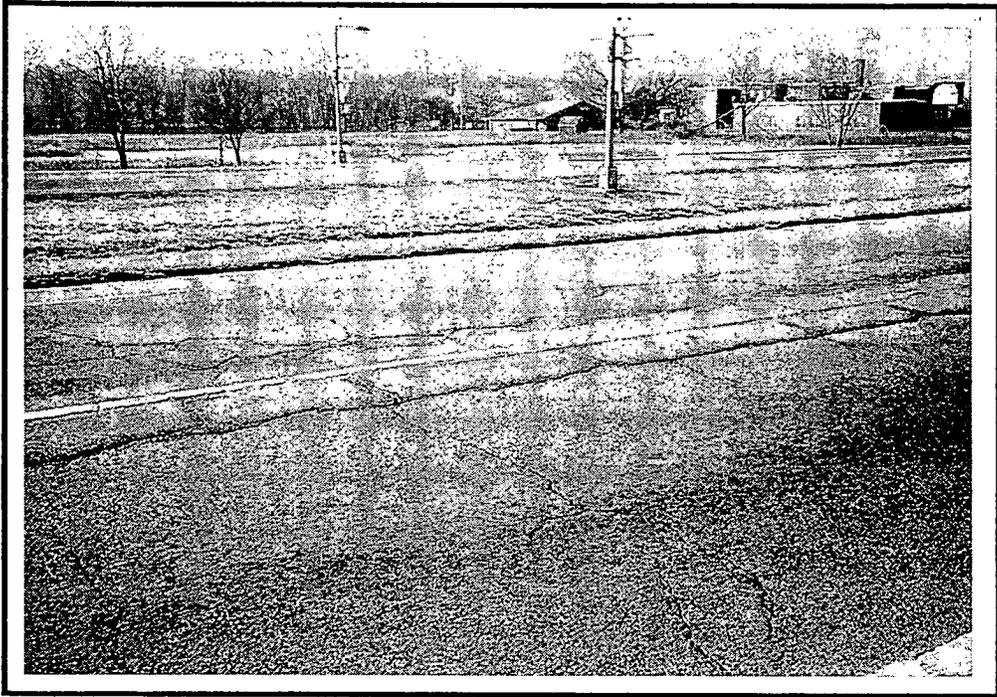


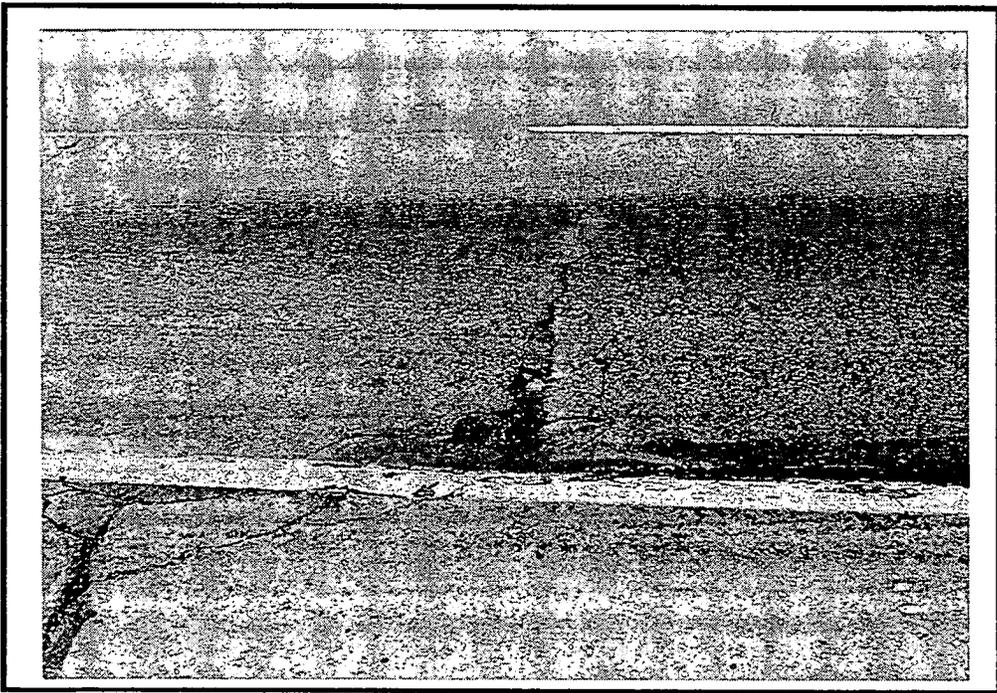
Photo A-8. Debonding in Flexible Pavement, Medium Severity

FLEXIBLE PAVEMENT

Distress Type:	Crack Sealing Deficiency
Description:	Crack sealing deficiency is crack sealing which is no longer effective in preventing intrusion of water or cracks which have never been sealed.
Severity Level:	Severity levels are not considered.
Extent Level:	Occasional-- less than 20 percent of the cracks along the pavement section are not effectively sealed.
	Frequent-- between 20 and 50 percent of the cracks along the pavement section are not effectively sealed.
	Extensive-- more than 50 percent of the cracks along the pavement section are not effectively sealed.



**Photo A-9. Crack Sealing Deficiency in Flexible Pavement,
Unsealed Cracks**



**Photo A-10. Crack sealing Deficiency in Flexible Pavement,
Cracks not sealed properly**

FLEXIBLE PAVEMENT

Distress Type: **Rutting**

Description: Ruts are vertical deformations in the pavement surface along the wheel tracks. In severe cases pavement uplift may occur along the sides of the rut, but in most instances only a depression is noticeable. Rutting is caused by consolidation or lateral movement of any or all pavement layers, including subgrade, under traffic.

Severity Level: Rutting severity is based upon rut depth, as approximated visually.

Low-- barely noticeable, depth less than 6 mm (1/4 inch).

Medium-- readily noticeable, depth more than 6 mm (1/4 inch), less than 25 mm (1 inch).

High-- definite effect upon vehicle control, depth greater than 25 mm (1 inch).

Extent Level: **Occasional--** less than 20 percent of the section length is rutted.

Frequent-- between 20 and 50 percent of the section length is rutted.

Extensive-- more than 50 percent of the section length is rutted.

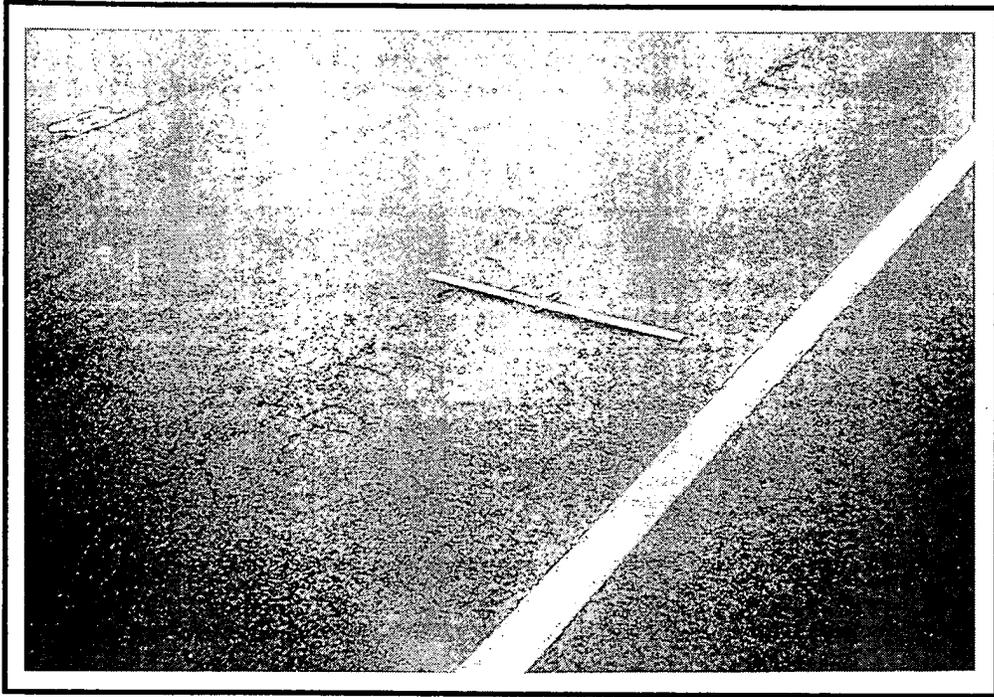


Photo A-11. Rutting in Flexible Pavement, Medium Severity

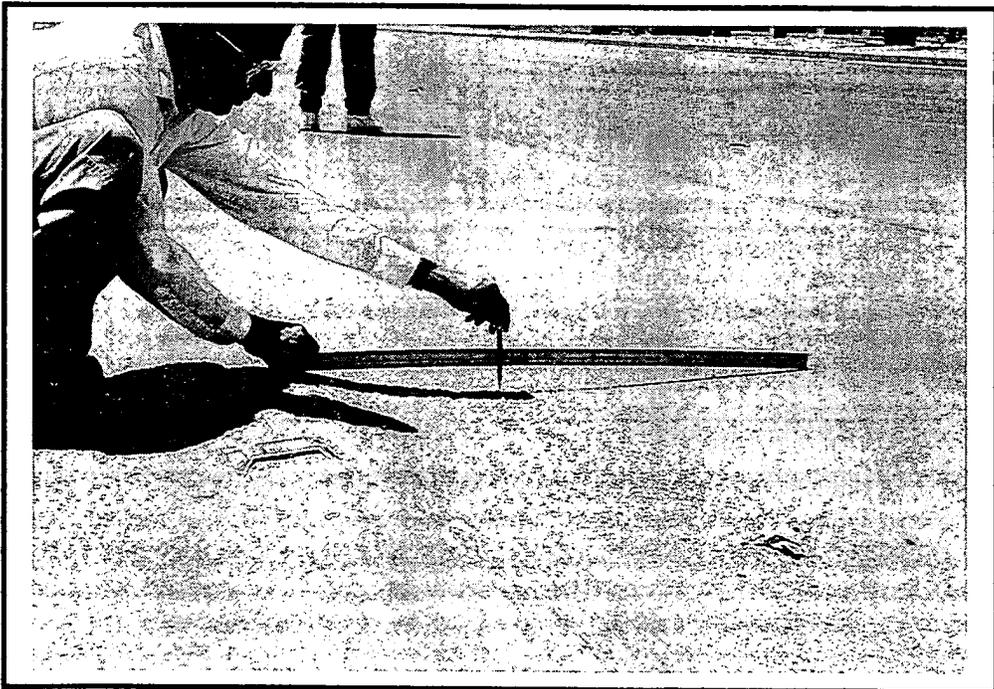


Photo A-12. Rutting in Flexible Pavement, High Severity

FLEXIBLE PAVEMENT

- Distress Type:** **Settlement**
- Description:** Settlement is a dip in the longitudinal profile of the pavement surface. Settlement shall be considered a distress when it causes a noticeable effect upon riding quality. Settlement should not be confused with corrugation, which is another type of surface profile deficiency.
- Severity Level:** Severity is based upon the effect of the settlement on vehicle control when traveling along the roadway at 60 km/hour (40 MPH), as discussed in step 1 of the monitoring procedure.
- Low--** noticeable effect upon ride, driver able to maintain vehicle control easily.
- Medium--** some discomfort to passengers, driver able to maintain control with slight corrective action.
- High--** definite effect upon ride quality, noticeable profile dip generally greater than 150 mm (6 inches). Poor ride, corrective action needed.
- Extent Level:** **Occasional--** less than 2 settlements/1.6 km (per mile) of roadway.
- Frequent--** 2 to 4 settlements/1.6 km (per mile) of roadway.
- Extensive--** more than 4 settlements/1.6 km (per mile) of roadway.

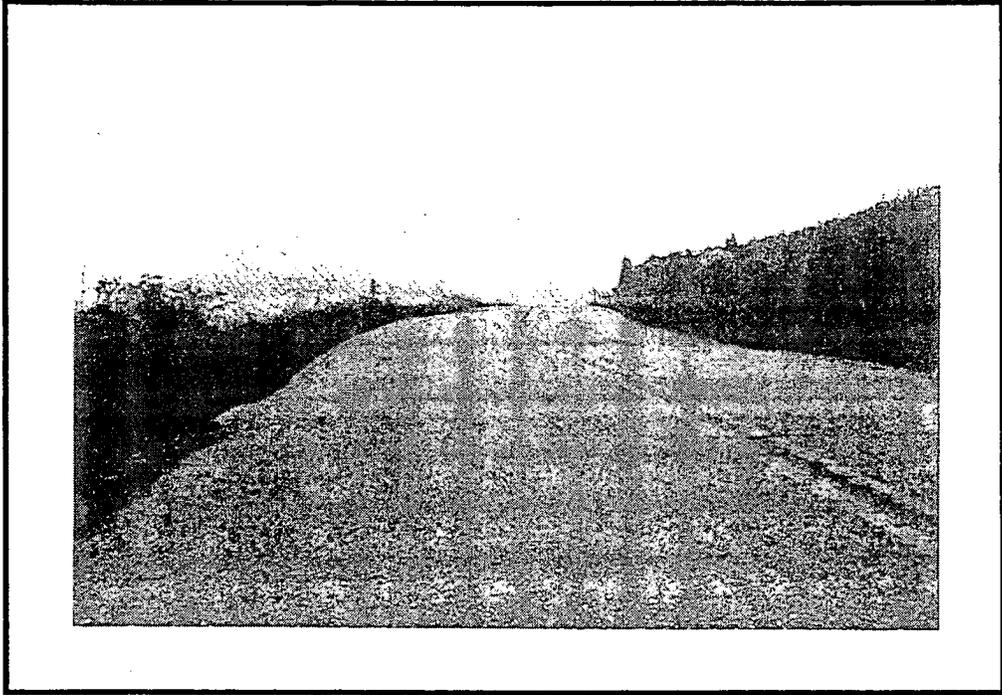


Photo A-13. Settlement, Low Severity

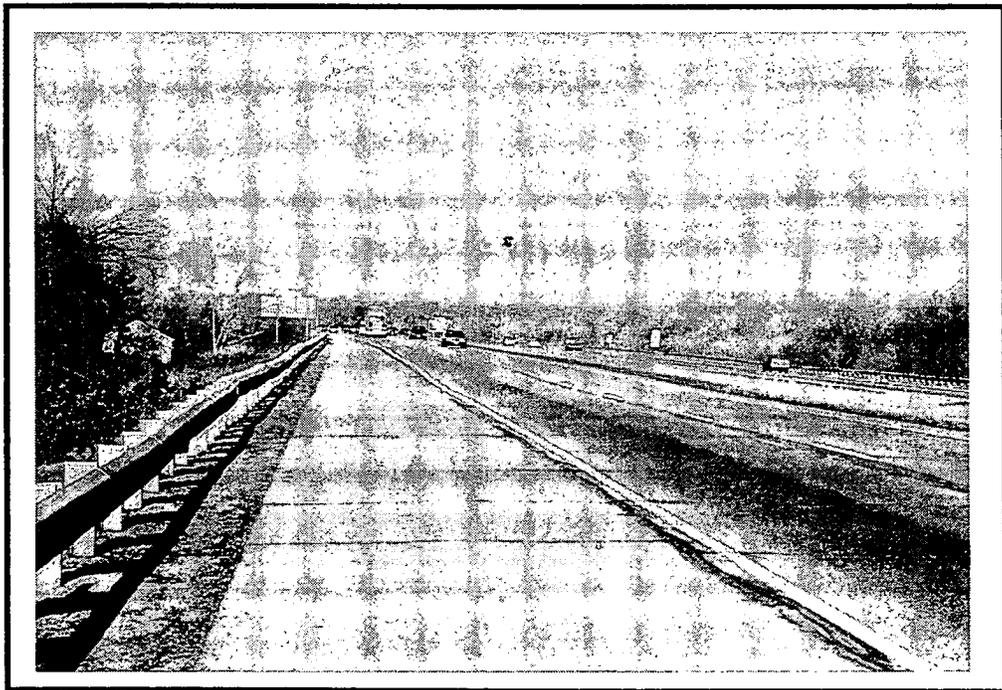


Photo A-14. Settlement, Medium Severity

FLEXIBLE PAVEMENT

Distress Type:	Corrugations
Description:	Corrugations are a series of transverse ridges and valleys (or ripples) occurring at regular intervals along the pavement. Unstable bituminous mixture or poor base quality are associated with this distress.
Severity Level:	Low-- noticeable effect upon ride, but no significant reduction in comfort. Medium-- moderate ride discomfort is noticeable, driver able to maintain vehicle control easily. High-- vehicle vibration is severe, speed reduction is necessary for comfort and to maintain vehicle control.
Extent Level:	Occasional-- less than 10 percent of the section length is affected by this distress. Frequent-- between 10 and 30 percent of the section length is affected by this distress. Extensive-- greater than 30 percent of the section length is affected by this distress.

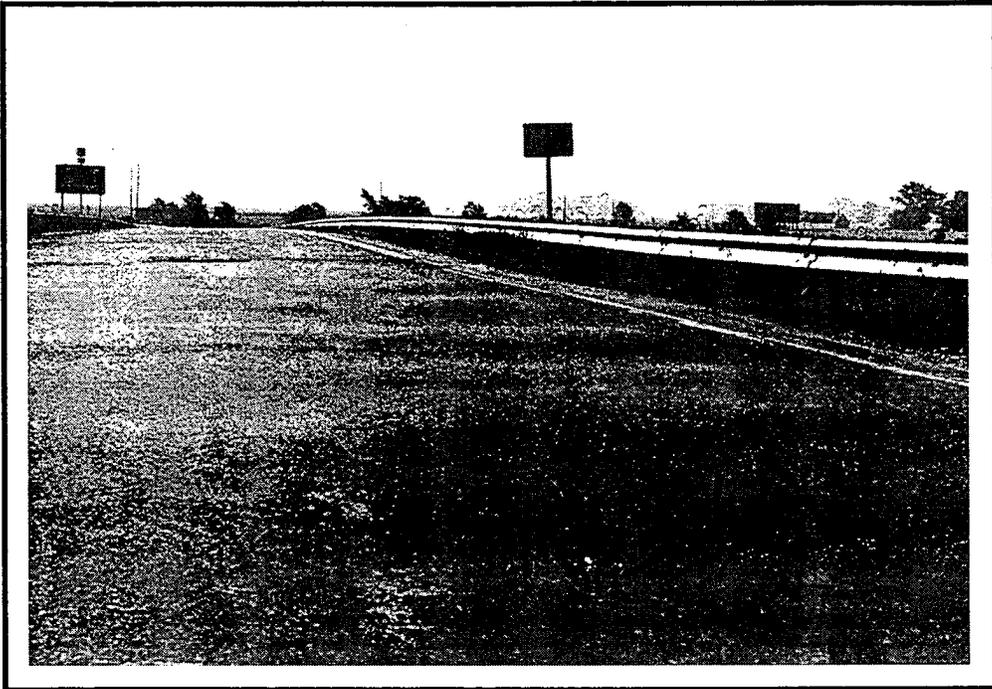


Photo A-15. Corrugations in Flexible Pavement, Medium Severity

FLEXIBLE PAVEMENT

Distress Type: **Wheel Track Cracking**

Description: Cracks located within or near the wheel tracks. For evaluation purposes each wheel track shall be considered 1 m (3 feet) in width. Wheel track cracking usually starts as intermittent, single longitudinal cracks progressing to multiple longitudinal cracking, and eventually interconnected or alligator cracking. Wheel track cracking usually results from fatigue failure of the asphaltic layer.

Severity Level: Severity is based upon both crack width and multiplicity of the cracking. Both criteria must be satisfied when assigning severity level.

Low-- single or intermittent multiple cracking with average crack width less than 6 mm (1/4 inch).

Medium-- single or multiple cracking (may also include regions of intermittent alligator cracking) with average crack width greater than 6 mm (1/4 inch) with little spalling or loose pieces.

High-- multiple cracking with extensive alligator cracking. Spalling is fairly common, with average crack width greater than 6 mm (1/4 inch), and some alligator blocks are easily removed.

Extent Level: Extent is based upon percentage of the wheel track length within the section which exhibits cracking.

Occasional-- less than 20 percent.

Frequent-- between 20 and 50 percent.

Extensive-- more than 50 percent.



Photo A-16. Wheel Track Cracking in Flexible Pavement, Med. Severity

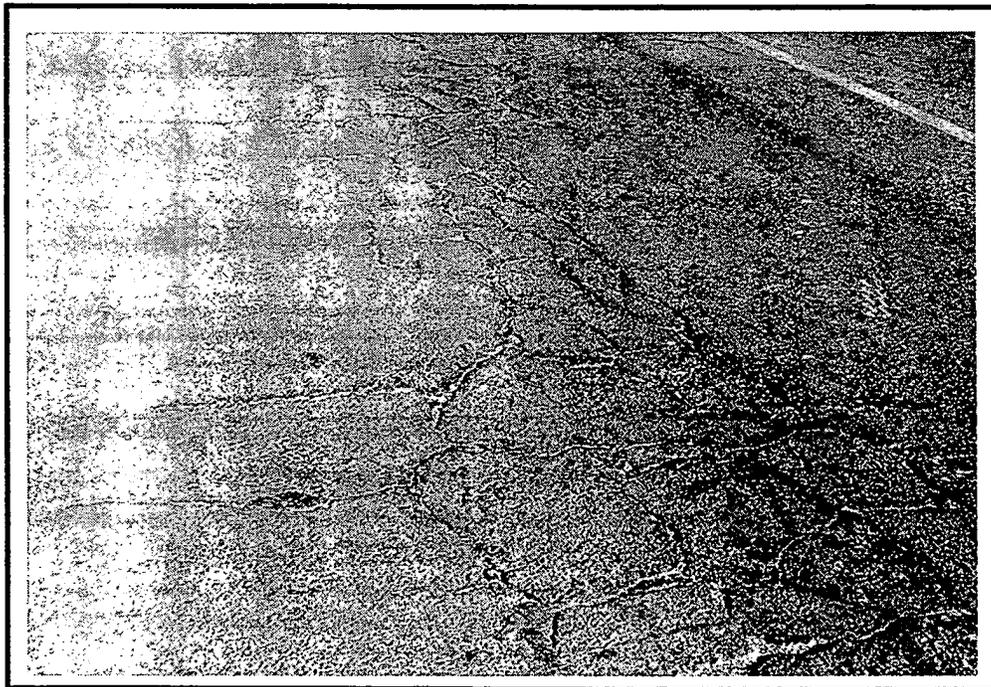


Photo A-17. Wheel Track Cracking in Flexible Pavement, High Severity

FLEXIBLE PAVEMENT

Distress Type: **Block and Transverse Cracking**

Description: Block cracks are interconnected cracks which divide the pavement into large rectangular pieces or blocks. Block size may range from 1 m by 1 m (3 ft. by 3 ft.) upwards to 3 m by 3 m (10 ft. by 10 ft.). Transverse cracking is cracks at approximately right angles to the pavement centerline. The occurrence of both block and/or transverse cracking is usually related to thermal shrinkage of the asphalt binder. Binder age hardening is also related to formation of these crack types.

Severity Level: **Low--** average crack width less than 6 mm (1/4 inch) with no spalling or distortion along crack edges.

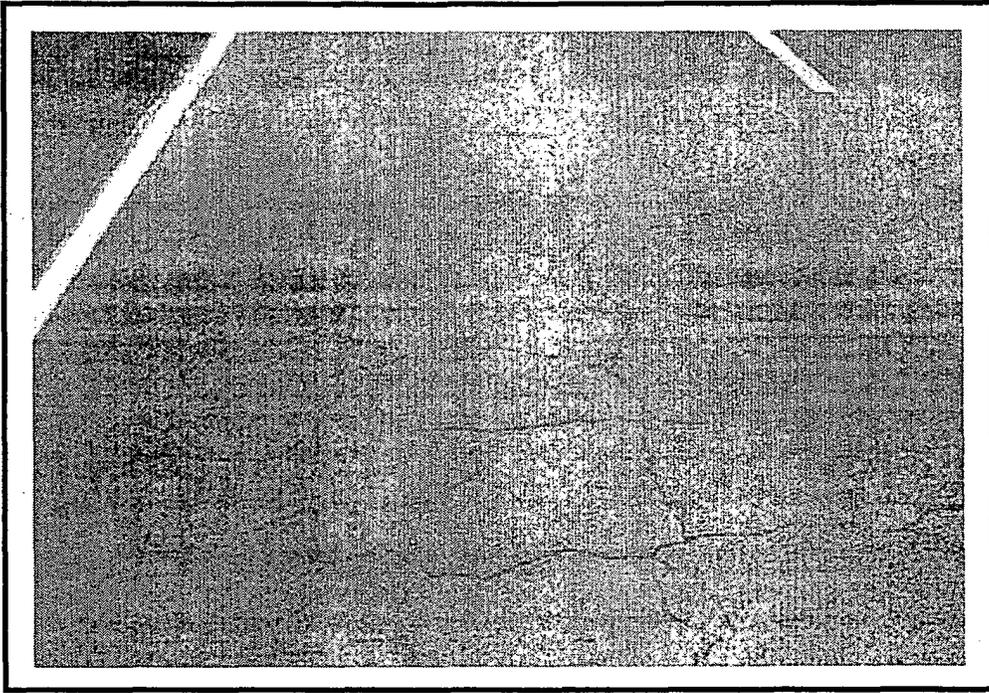
Medium-- average crack opened or spalled to a width between 6 mm to 25 mm (1/4 to 1 inch) along at least half its length.

High-- average crack opened or spalled to a width greater than 25 mm (1 inch) along at least half its length.

Extent Level: **Occasional--** less than 20 percent of the section length is affected by this distress.

Frequent-- between 20 and 50 percent of this section length is affected by this distress.

Extensive-- greater than 50 percent of the section length is affected by this distress.



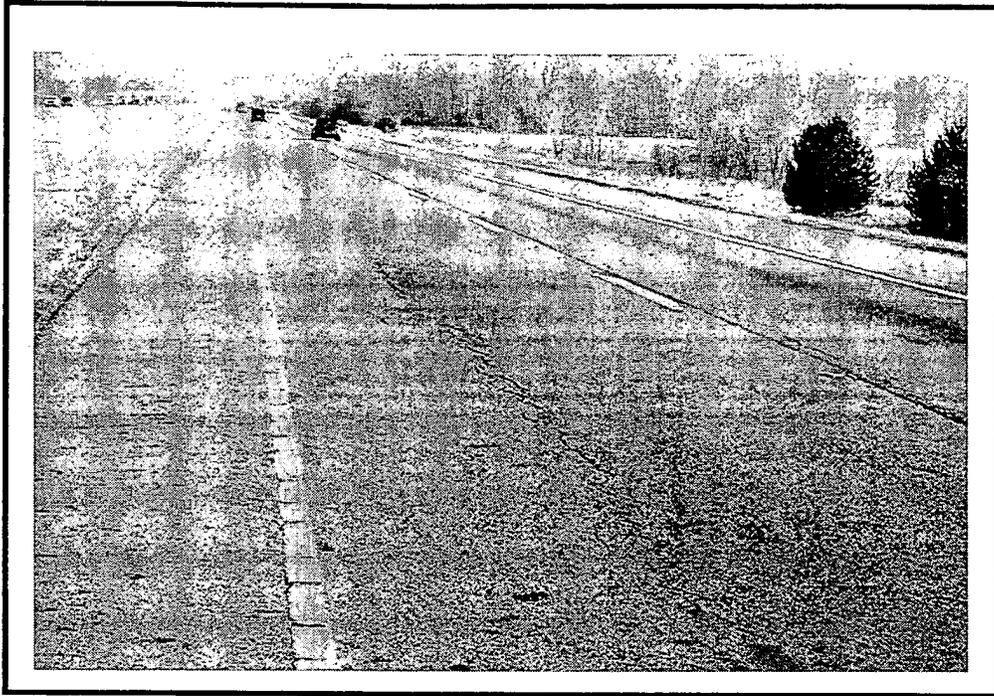
**Photo A-18. Block and Transverse Cracking in Flexible Pavement,
Medium Severity**



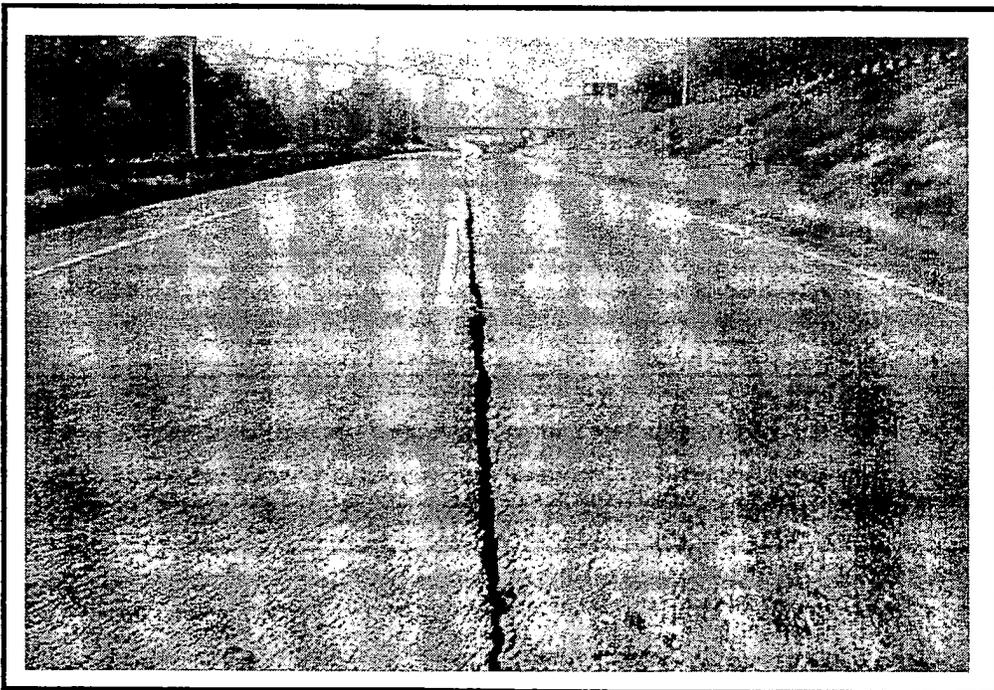
**Photo A-19. Block and Transverse Cracking in Flexible Pavement,
High Severity**

FLEXIBLE PAVEMENT

Distress Type:	Longitudinal Joint Cracking
Description:	Deterioration or cracking of the longitudinal joints formed by separate passes of an asphalt paver, including shoulders and widening. Poor compaction along the longitudinal joint often results in the disintegration of material along the joint and may be accompanied by single or multiple cracking.
Severity Level:	Low-- deterioration < 25 mm (1") wide at the surface, or single crack < 6 mm (1/4") wide and no spalling. Medium-- deterioration 25 mm - 50 mm (1"-2") wide at the surface and may extend down to the intermediate course, or single or multiple cracking 6 mm - 25 mm (1/4"-1") with some spalling. High-- deterioration > 50 mm (2") wide at the surface and likely extending down to the intermediate course or lower, or multiple cracking > 25 mm (1") wide with much spalling.
Extent Level:	Based upon the average linear feet of longitudinal cracking per 30 m (per station of 100 feet length). Occasional-- less than 15 m/30 m (50 feet per station). Frequent-- between 15 and 45 m/30 m (50 and 150 feet per station). Extensive-- more than 45 m/30 m (150 feet per station). Complete longitudinal joint cracking along the pavement centerline and edge [60 linear m/ 30 m (200 linear feet per station)] is termed extensive.



**Photo A-20. Longitudinal Joint Cracking in Flexible Pavement,
Medium Severity**



**Photo A-21. Longitudinal Joint Cracking in Flexible Pavement,
High Severity**

FLEXIBLE PAVEMENT

Distress Type: **Edge Cracking**

Description: Edge cracks are longitudinal or crescent shaped cracks usually within 0.3 m (1 foot) of the pavement edge line.

Severity Level: **Low--** tight cracks, width less than 6 mm (1/4 inch) with no break up or spalling.

Medium-- crack width greater than 6 mm (1/4 inch) with some spalling.

High-- multiple cracking with moderate spalling and average crack width greater than 6 mm (1/4 inch).

Extent Level: **Occasional--** cracking occurs along less than 20 percent of the pavement edge within the section.

Frequent-- cracking occurs along 20 to 50 percent of the pavement edge within the section.

Extensive-- cracking occurs along more than 50 percent of the pavement edge within the section.

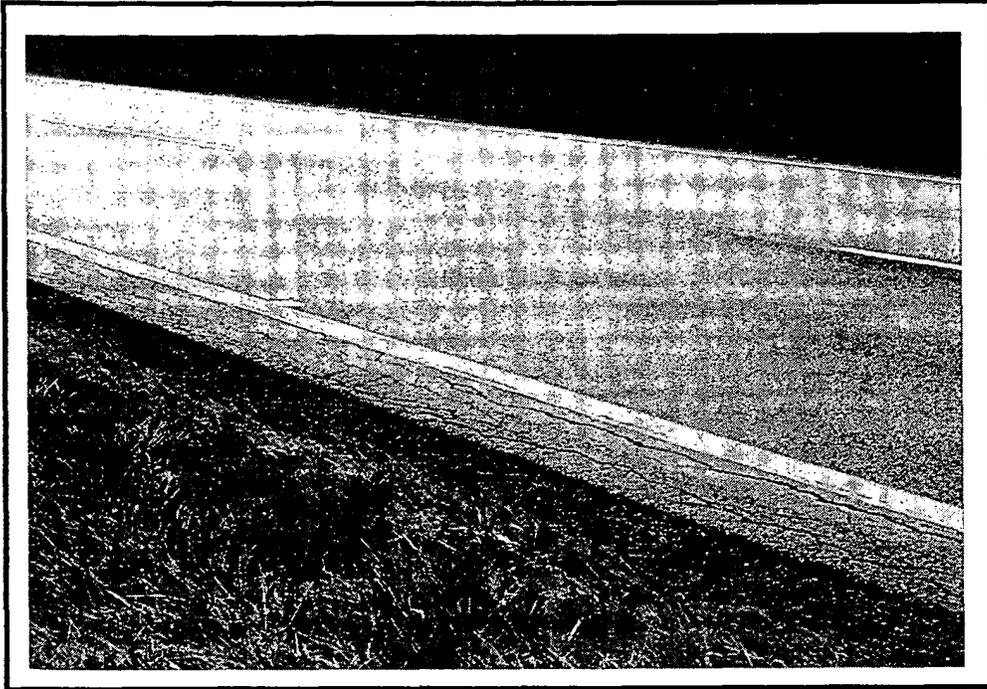


Photo A-22. Edge Cracking in Flexible Pavement, Medium Severity

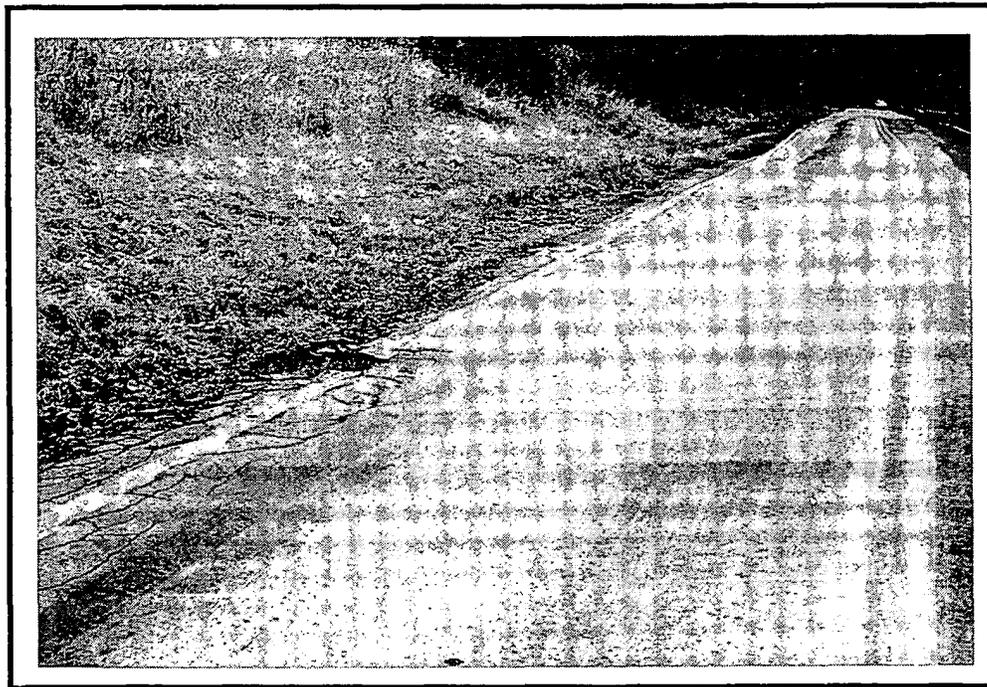


Photo A-23. Edge Cracking in Flexible Pavement, High Severity

FLEXIBLE PAVEMENT

Distress Type: **Random Cracking**

Description: Random cracks are those cracks which are not categorized as one of the 4 previous types of cracks. For example, cracks which meander across or along the pavement would be classified as random cracks.

Severity Level: **Low--** average crack width less than 6 mm (1/4 inch), no spalling.

Medium-- average crack opened or spalled to a width between 6 mm to 25 mm (1/4 to 1 inch) along at least half of its length.

High-- average crack opened or spalled to a width greater than 25mm (1 inch) along at least half of its length.

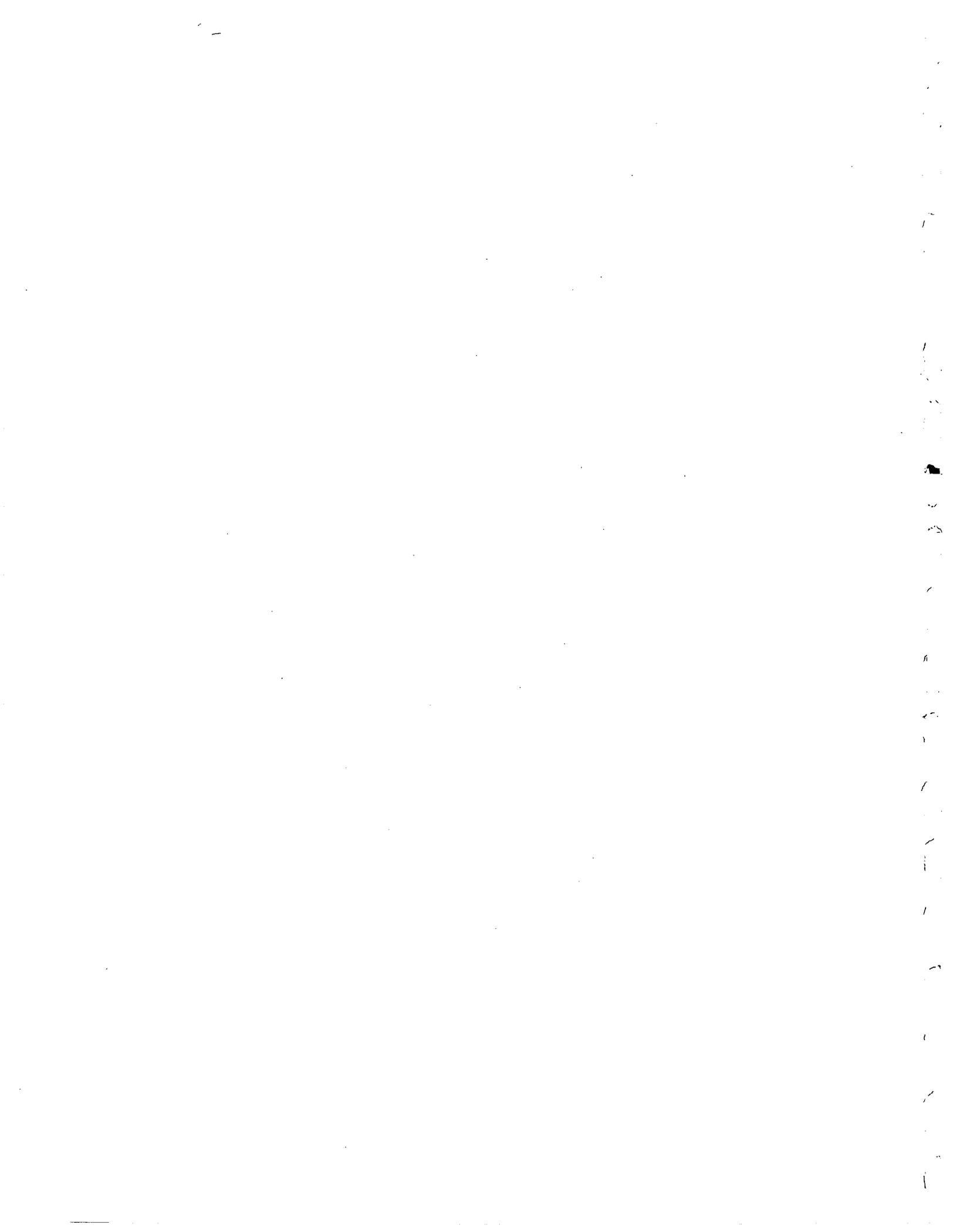
Extent Level: **Occasional--** random cracks occur along less than 20 percent of the section.

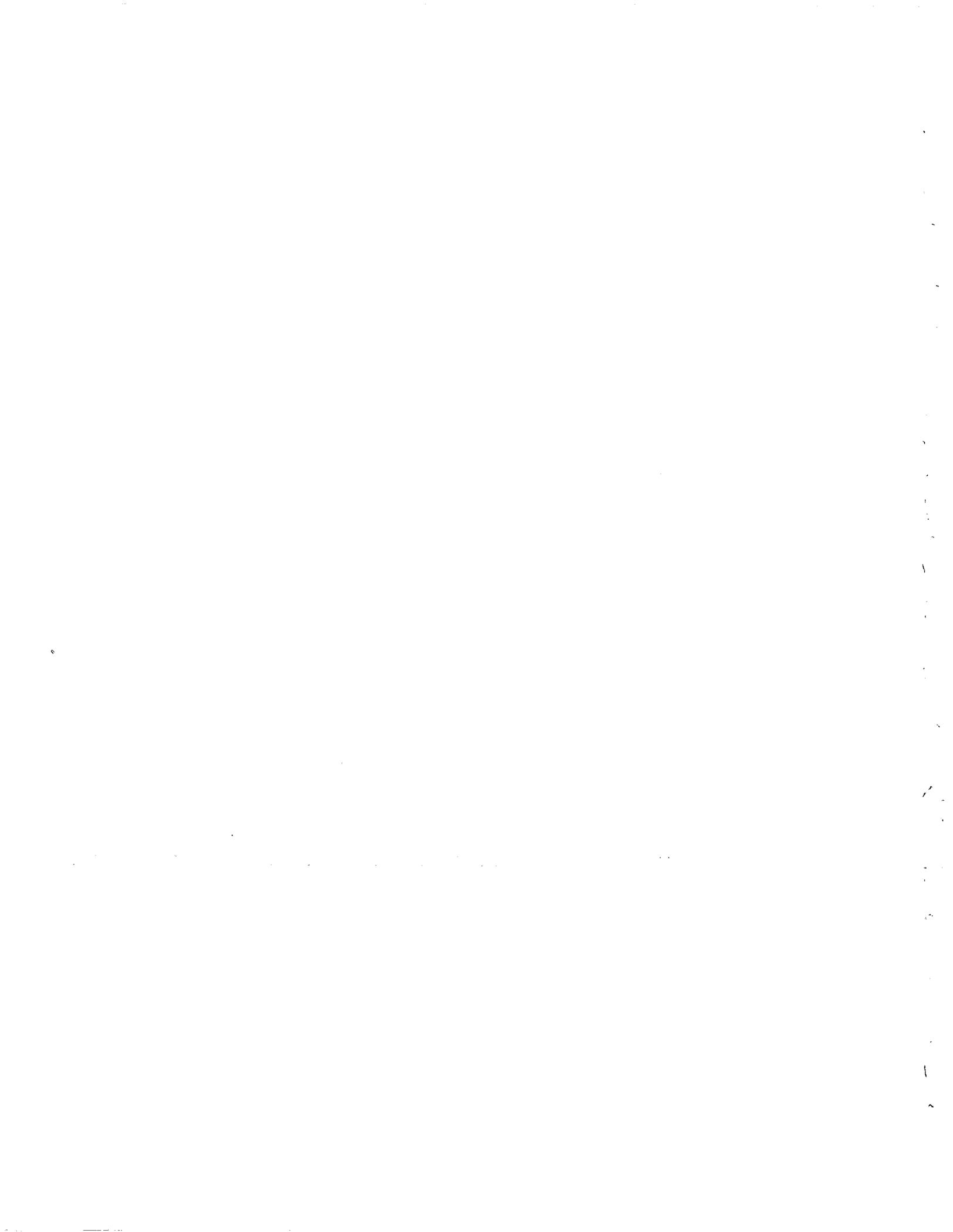
Frequent-- random cracks occur along 20 to 50 percent of the section.

Extensive-- random cracks occur along more than 50 percent of the section.



Photo A-24. Random Cracking in Flexible Pavement, Medium Severity





APPENDIX B

Description of Distresses in Composite Pavements

**[Composite Pavements have rigid bases (concrete or brick)
and asphaltic surfaces]**

COMPOSITE PAVEMENT

Distress Type:	Raveling
Description:	Disintegration of the pavement from the surface downward due to the loss of aggregate particles. Raveling may occur as a result of asphalt binder aging, poor mixture quality segregation, or insufficient compaction.
Severity Level:	Low-- very little coarse aggregate has worn away. Loss of fine aggregate. Coarse aggregate exposed.
	Medium-- surface has an open texture and is moderately rough with considerable loss of fine aggregate and some coarse aggregate removed.
	High-- most of the surface aggregate has worn away or become dislodged. Surface is severely rough and pitted and may be completely removed in places.
Extent Level:	Occasional-- less than 20 percent of the surface area is raveling.
	Frequent-- between 20 and 50 percent of the surface area is raveling.
	Extensive-- more than 50 percent of the surface area is raveling.

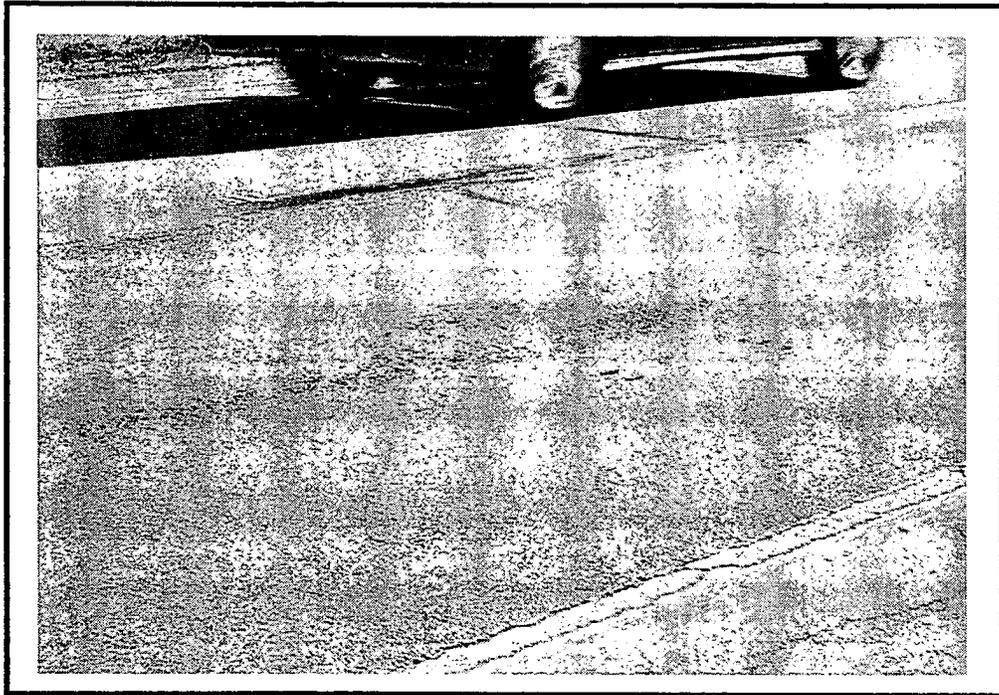


Photo B-1. Raveling in Composite Pavement, Medium Severity

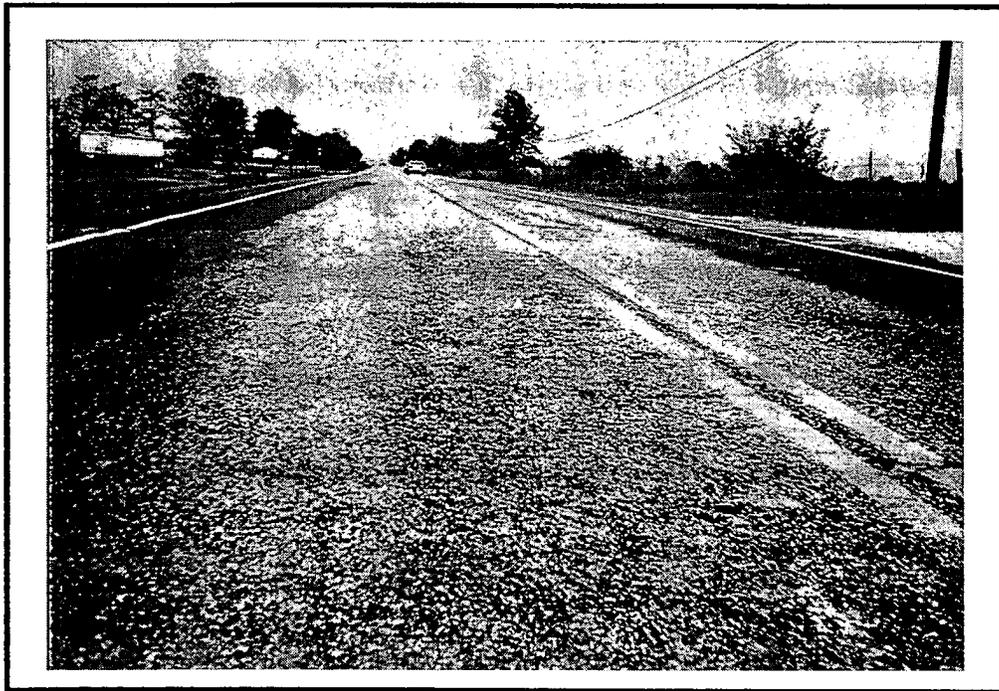


Photo B-2. Raveling in Composite Pavement, High Severity

COMPOSITE PAVEMENT

Distress Type:	Bleeding
Description:	Bleeding or flushing is the presence of free asphalt binder on the pavement surface. Bleeding is caused by an excess amount of bituminous binder in the mixture and/or low air void content.
Severity Level:	Only 2 severity levels are defined. Medium-- both coarse aggregate and free bitumen are noticeable at the pavement surface. High-- surface appears black with very little aggregate noticeable.
Extent Level:	Occasional-- less than 10 percent of the length exhibits bleeding. Frequent-- between 10 and 30 percent of the length is bleeding. Extensive-- bleeding occurs in more than 30 percent of the length.

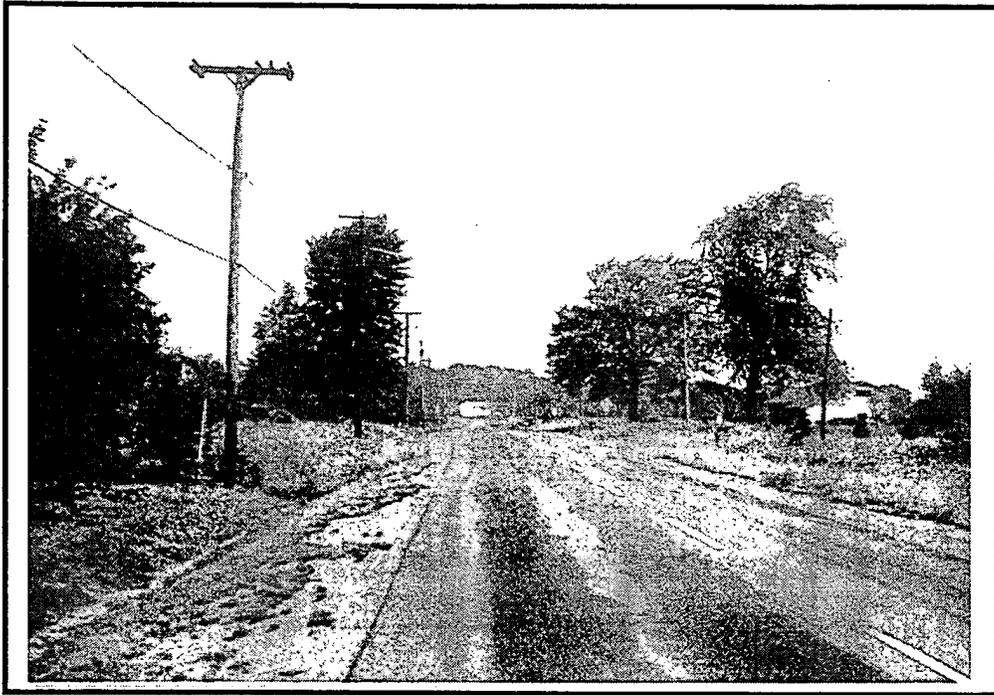


Photo B-3. Bleeding, High Severity

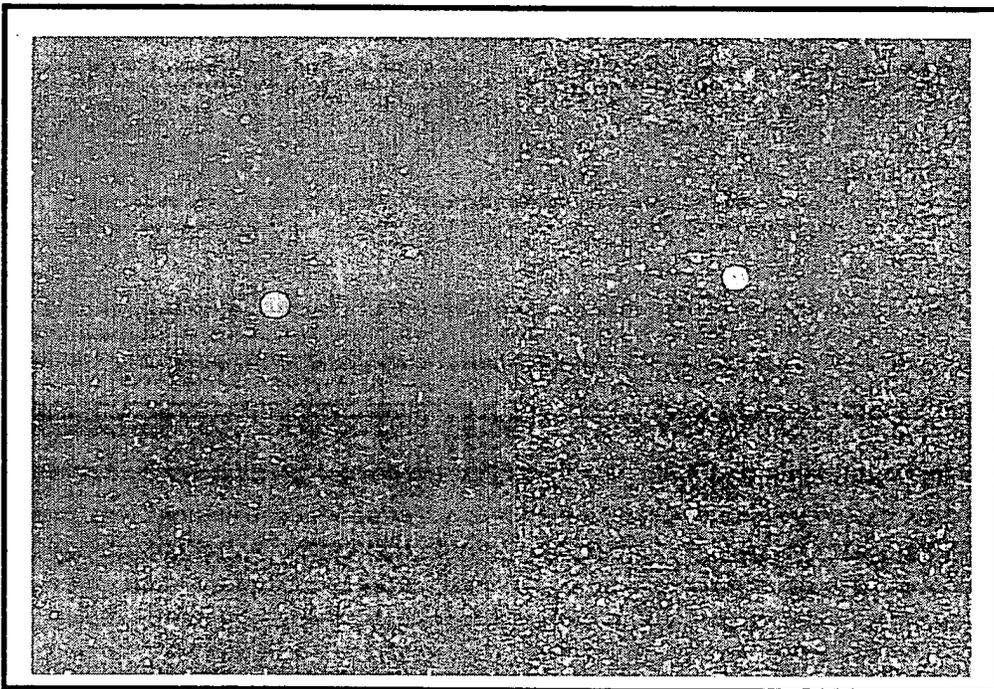


Photo B-4. Close-up view of Bleeding, High and Medium Severity
High Severity on left shows most aggregates covered with asphalt and Medium Severity on right shows less aggregates covered with asphalt

COMPOSITE PAVEMENT

Distress Type: Patching

Description: Patching is either the placing of asphalt concrete on the surface of the existing pavement or the replacement of the existing pavement in small isolated areas.

Deductions shall be made for all patches present in the pavement which are the result of deterioration and/or maintenance since the last construction project.

Large patched areas [greater than 12.5 m² (15 S.Y.)], such as spot overlays or wedge courses, shall be rated for condition as a part of the existing pavement rather than as patches.

Severity Level: Low-- patch size < 0.1 m² (1 sq. ft.).

Medium-- patch size < 0.8 m² (1 sq. yd.).

High-- patch size > 0.8 m² (1 sq. yd.).

Extent Level: Occasional-- < 10 patches/1.6 km (per mile).

Frequent-- 10 - 20 patches/1.6 km ((per mile).

Extensive-- > 20 patches/1.6 km ((per mile).

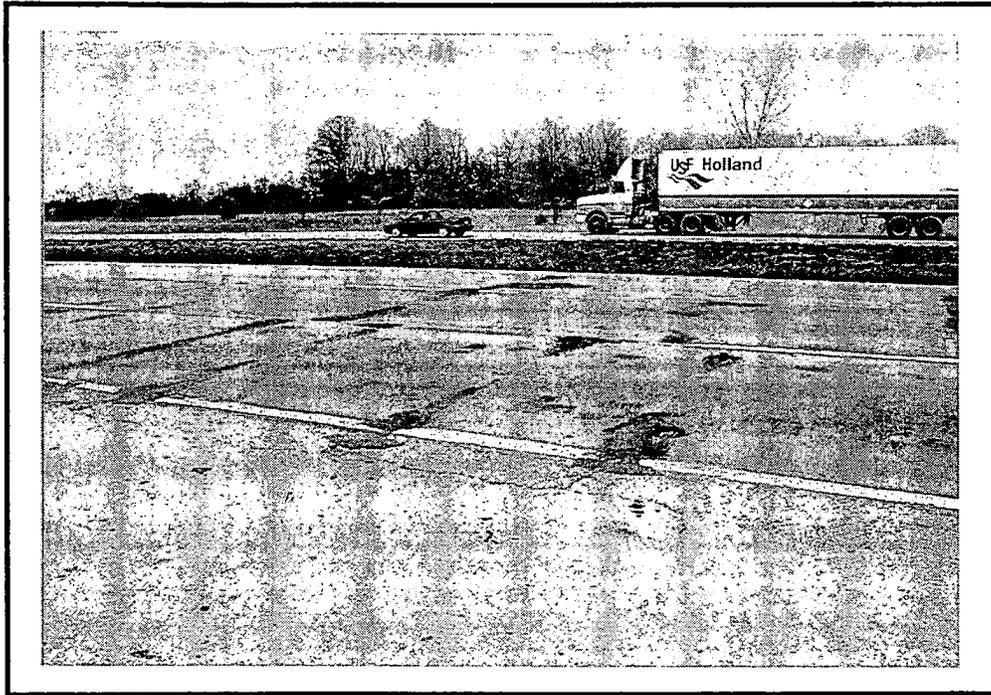


Photo B-5. Patching in Composite Pavement, Medium Severity

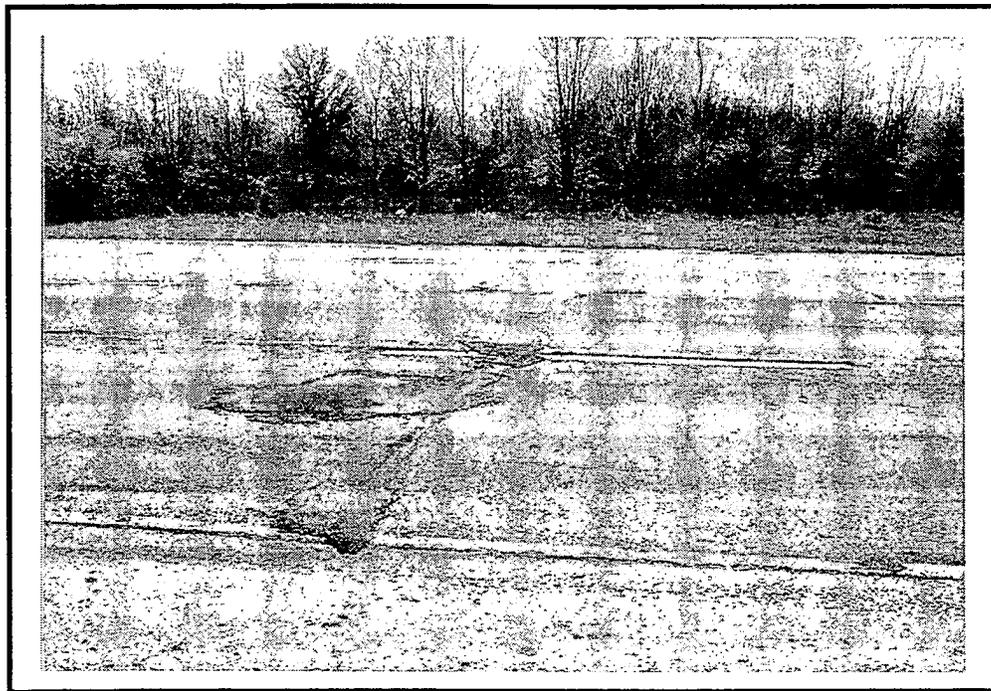


Photo B-6. Patching in Composite Pavement, High Severity

COMPOSITE PAVEMENT

Distress Type: Surface Disintegration or Debonding

Description: Loss of surface by debonding is the removal of the asphaltic surface layer from the underlying layer. The problem is most common with thin asphalt surface layers [less than 50 mm (2 inches)] and is caused by freeze-thaw action or poor bonding of the two layers during construction.

Severity Level: Use the following table:

Depth of Debonded Area	Debonded Area <0.8 m ² (1 sq. yd.)	Debonded Area >0.8 m ² (1 sq. yd.)
< 25 mm (1")	Low	Medium
> 25 mm (1")	Medium	High

Extent Level: Occasional-- debonding occurs along less than 20 percent of the section length.

Frequent-- debonding occurs along 20 to 50 percent of the section length.

Extensive-- debonding occurs along more than 50 percent of the section length.

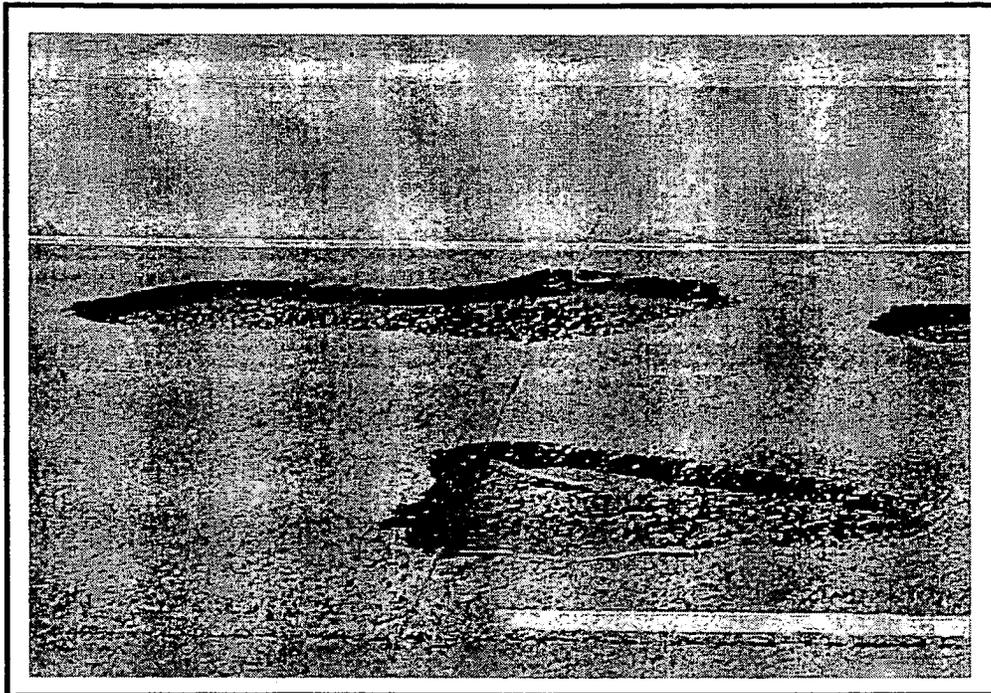


Photo B-7. Surface Disintegration in Composite Pavement

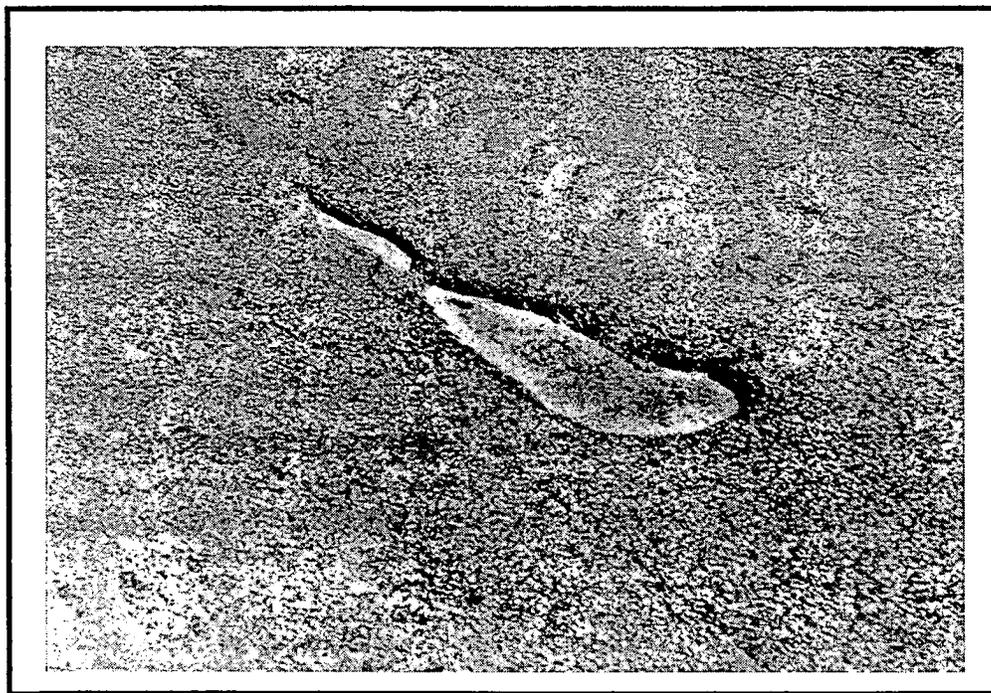


Photo B-8. Debonding in Composite Pavement, Medium Severity

COMPOSITE PAVEMENT

Distress Type: Rutting

Description: Ruts are vertical deformations in the pavement surface along the wheel tracks. In severe cases pavement uplift may occur along the sides of the rut, but in most instances only a depression is noticeable. Rutting is caused by consolidation or lateral movement of any or all pavement layers, including subgrade, under traffic.

Severity Level: Rutting severity is based upon rut depth, as approximated visually.

Low-- barely noticeable, depth less than 6 mm (1/4 inch).

Medium-- readily noticeable, depth more than 6 mm (1/4 inch), less than 25 mm (1 inch).

High-- definite effect upon vehicle control, depth greater than 25 mm (1 inch).

Extent Level: **Occasional--** less than 20 percent of the section length is rutted.

Frequent-- between 20 and 50 percent of the section length is rutted.

Extensive-- more than 50 percent of the section length is rutted.

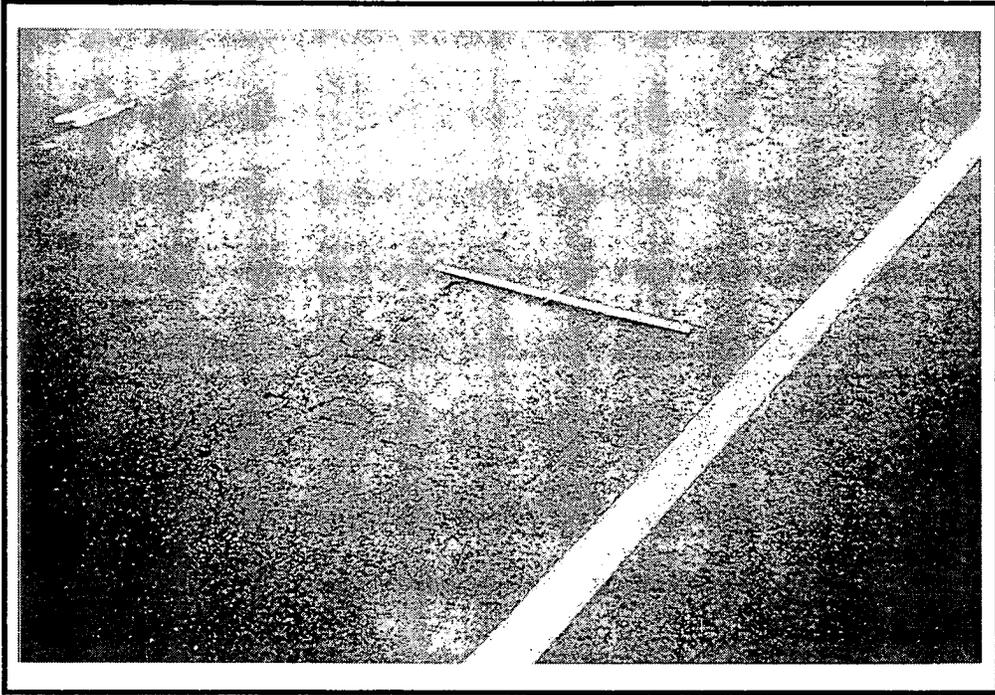


Photo B-9. Rutting, Medium Severity

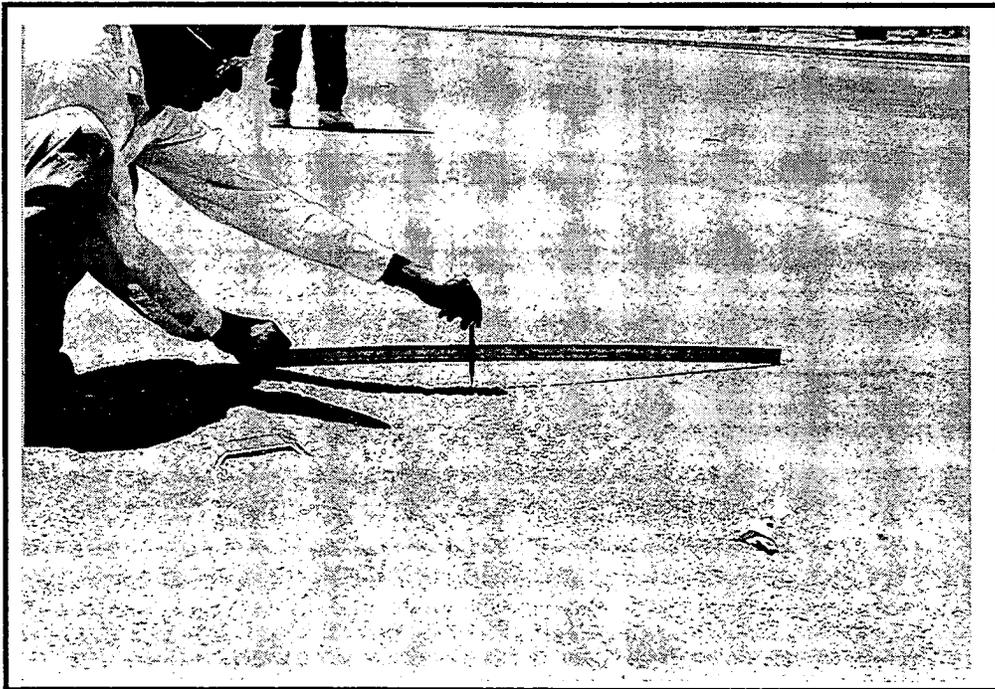


Photo B-10. Rutting, High Severity

COMPOSITE PAVEMENT

Distress Type: Pumping

Description: Pumping is the ejection of fine soil particles through pavement cracks, joints, or along pavement edges. Pumping can be identified by the presence of surface staining and base or subgrade material near joints or cracks. Shoulder disintegration at the pavement edge is often an indicator of pumping beneath the slab.

Severity Level: Severity is based upon the rater's degree of certainty that pumping is occurring as indicated by visual evidence.

L & M-- Some staining of the surface around cracks or joints is noted. Rater is quite certain that pumping exists.

High-- Clear evidence that pumping exists. Excessive staining, medium severity or greater, faulting, corner breaks or punchouts. Rater is quite certain that pumping exists.

Extent Level: **Occasional--** Less than 10 of the joints and cracks exhibit pumping.

Frequent-- 10 to 25 percent of the joints and cracks exhibit pumping.

Extensive-- More than 25 percent of the joints and cracks exhibit pumping.

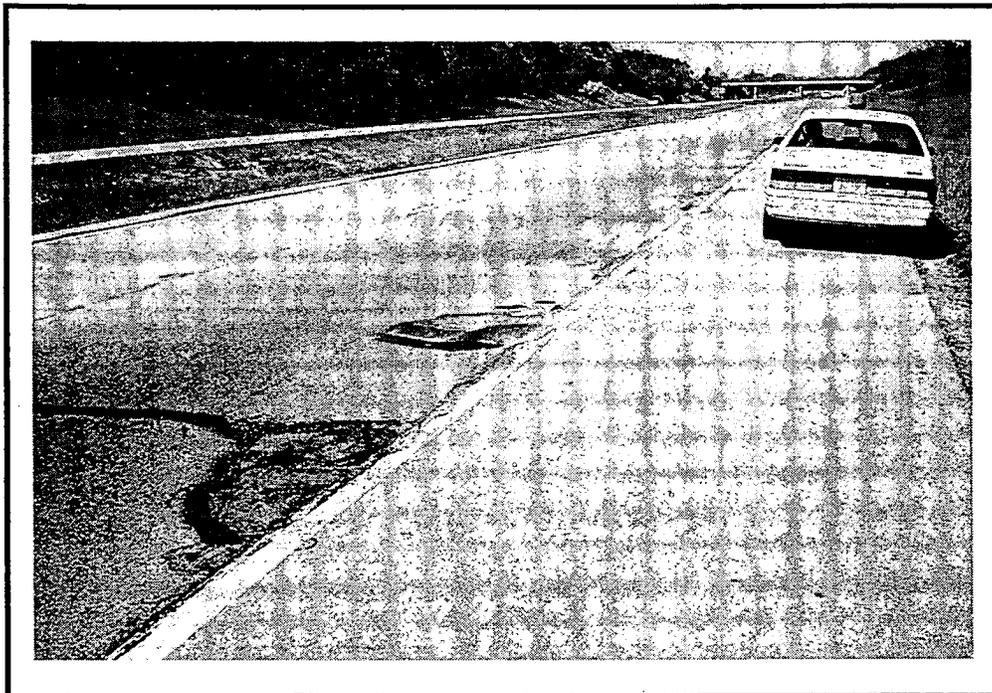


Photo B-11. Pumping in Composite Pavement, Medium Severity



Photo B-12. Pumping in Composite Pavement, High Severity

COMPOSITE PAVEMENT

Distress Type: Transverse Cracking

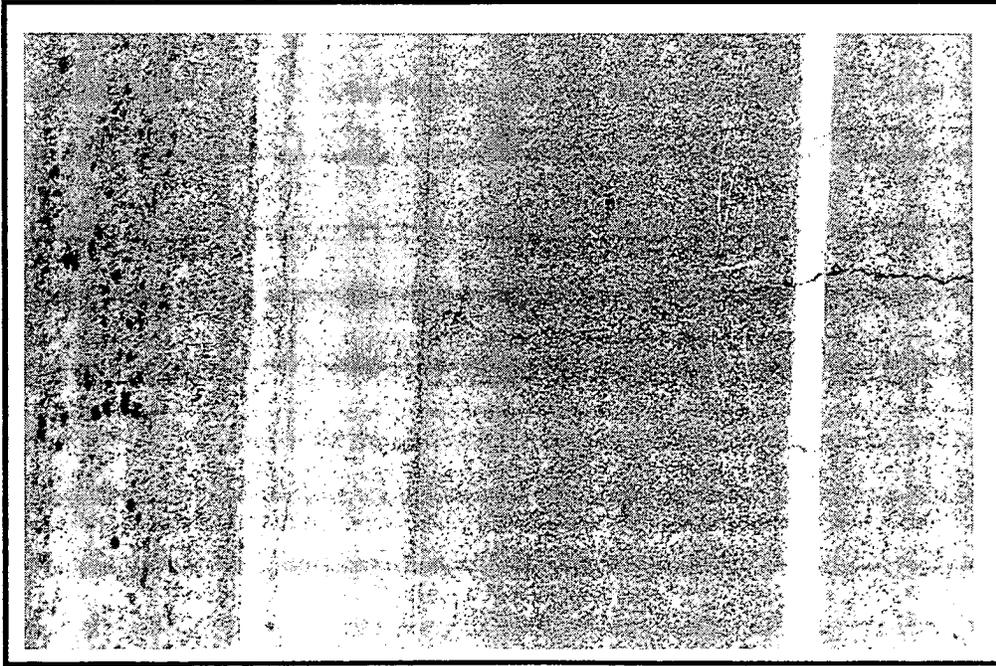
Description: A crack or break at approximately right angles to the pavement centerline. For composite pavements where the rigid base layer does not have transverse joints (CRC pavements for instance) all transverse cracking is evaluated regardless of location. For jointed bases, a separate evaluation is made of reflective cracks at 1) the joints; and 2) other (non-joint) transverse cracking. Usually all underlying base cracks and joints are eventually reflected through the flexible surface. Additional transverse surface cracking may result from thermal shrinkage and age hardening of the asphaltic layer.

Note 1: A significant amount of joint repair and bituminous overlay of Jointed Concrete (JC) pavement has been completed in Ohio. The repair method usually included removal of original pavement at the joint for ± 1 m (3 feet) in each adjacent slab and replacing it with an asphalt or concrete patch. For projects which contain this type of repair, both transverse joints will be evaluated if visible.

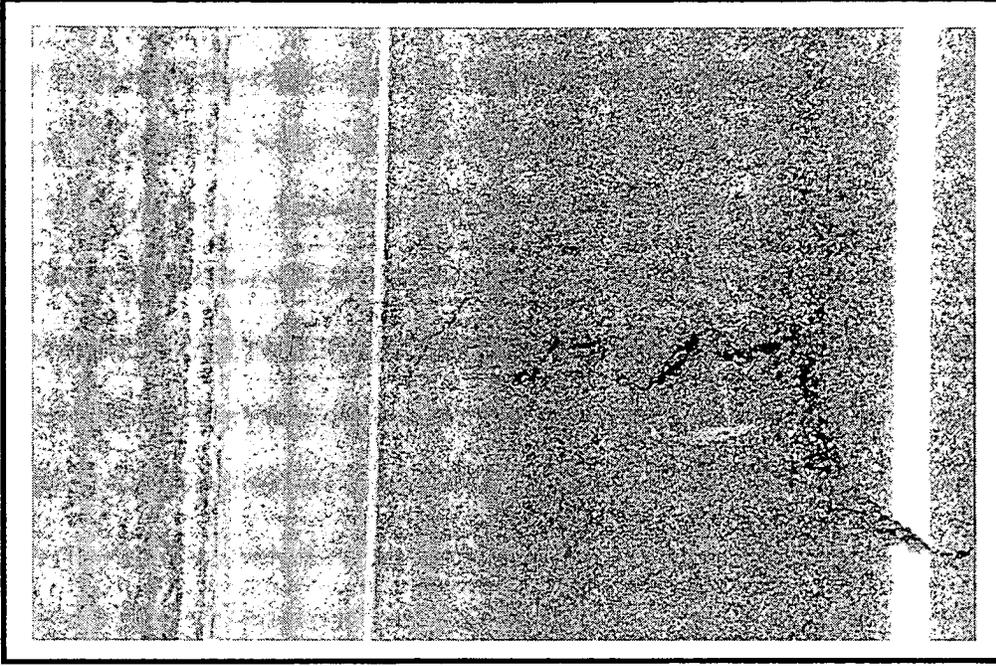
Note 2: Crack width is defined as the sum of all cracks if more than one is present at the location of measurement (measured as a continuous length from the beginning of the first crack to the end of the last crack).

Severity Level: Unjointed Base or Jointed Base

- Low--** crack width less than 6 mm (1/4 inch) with no spalling or distortion along crack edges.
- Medium--** crack opened or spalled to a width between 6 mm and 25 mm (1/4 and 1 inch) over at least one half its length.
- High--** crack opened or spalled to a width greater than 25 mm (1 inch) over at least one half its length.



**Photo B-15. Unjointed Base, Transverse
Cracking in Composite Pavement, Low
Severity**



**Photo B-16. Unjointed Base, Transverse
Cracking in Composite Pavement, High
Severity**

COMPOSITE PAVEMENT

Extent Level: **Jointed Base - Intermediate Transverse Cracking**

Extent level is based upon average crack spacing (CS) as given by the following formula:

$$CS = L / (Z + 1)$$

Where:

CS	=	average crack spacing in m (ft.),
Z	=	average number of transverse cracks per panel, and
L	=	transverse joint spacing in m (ft.).

(Please Note: average CS is based on Step 2 observations).

- Occasional-- average transverse crack spacing greater than 4.5 m (15 feet).
- Frequent-- average spacing 3 to 4.5 m (10 to 15 feet).
- Extensive-- average crack spacing less than 3 m (10 feet).

Extent Level: **Unjointed Base**

- Occasional-- average intermediate transverse crack spacing greater than 4.5 m (15 feet).
- Frequent-- average intermediate transverse crack spacing 3 to 4.5 m (10 to 15 feet).
- Extensive-- average intermediate transverse crack spacing less than 3 m (10 feet).

Extent Level: **Jointed Base-Joint Reflection Cracks**

Extent is based upon the estimated percentage of transverse joint length which has reflected through the asphalt surface. Except for new pavements or overlays the extent will likely be extensive.

- Occasional-- less than 20 percent.
- Frequent-- between 20 and 50 percent.
- Extensive-- more than 50 percent.

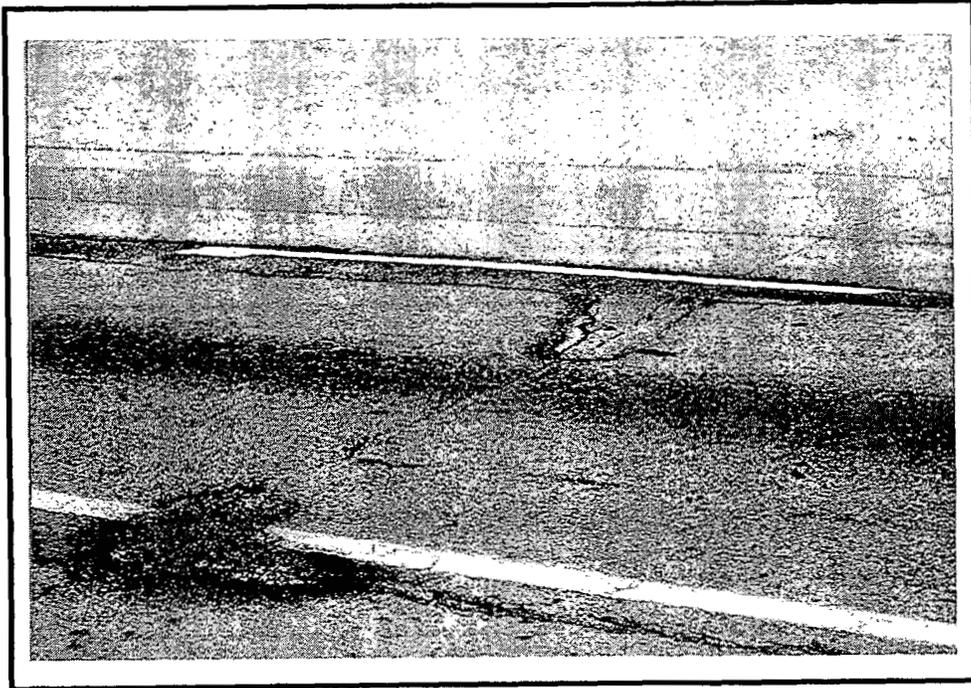


Photo B- 17. Jointed Base, Reflection Cracking in Composite Pavement, Medium Severity

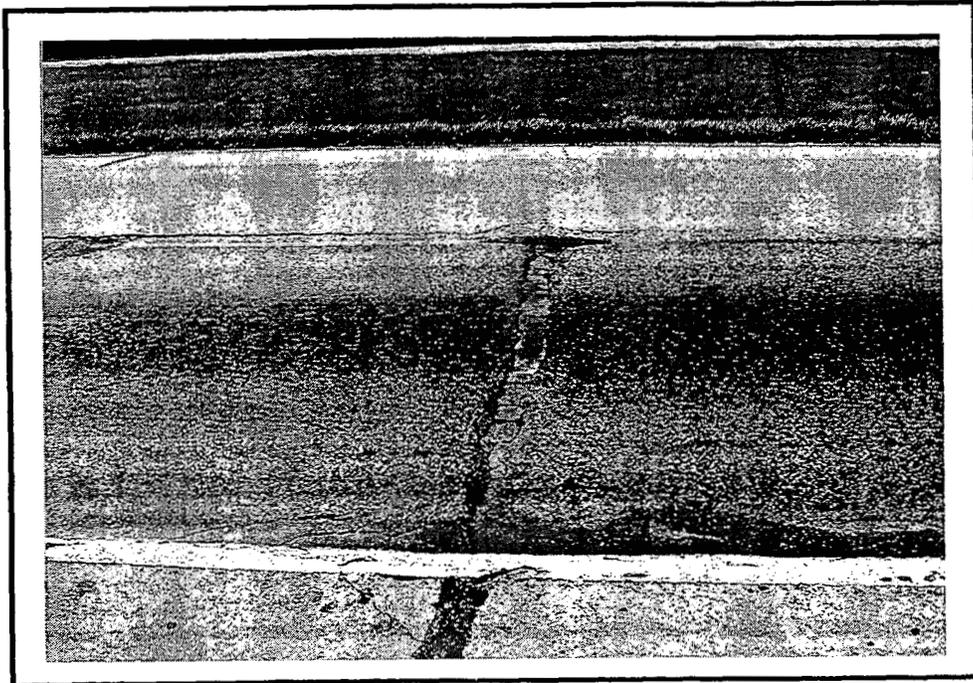


Photo B- 18. Jointed Base, Reflection Cracking in Composite Pavement, High Severity

COMPOSITE PAVEMENT

Distress Type: Crack Sealing Deficiency

Description: Crack sealing deficiency is crack sealing which is no longer effective in preventing intrusion of water or cracks which have never been sealed.

Severity Level: Severity levels are not considered.

Extent Level: Extent is based upon the percentage of crack length in the pavement surface which is not effectively sealed.

Occasional-- less than 20 percent of the cracks along the pavement section are not effectively sealed.

Frequent-- between 20 and 50 percent of the cracks along the pavement section are not effectively sealed.

Extensive-- more than 50 percent of the cracks along the pavement section are not effectively sealed.

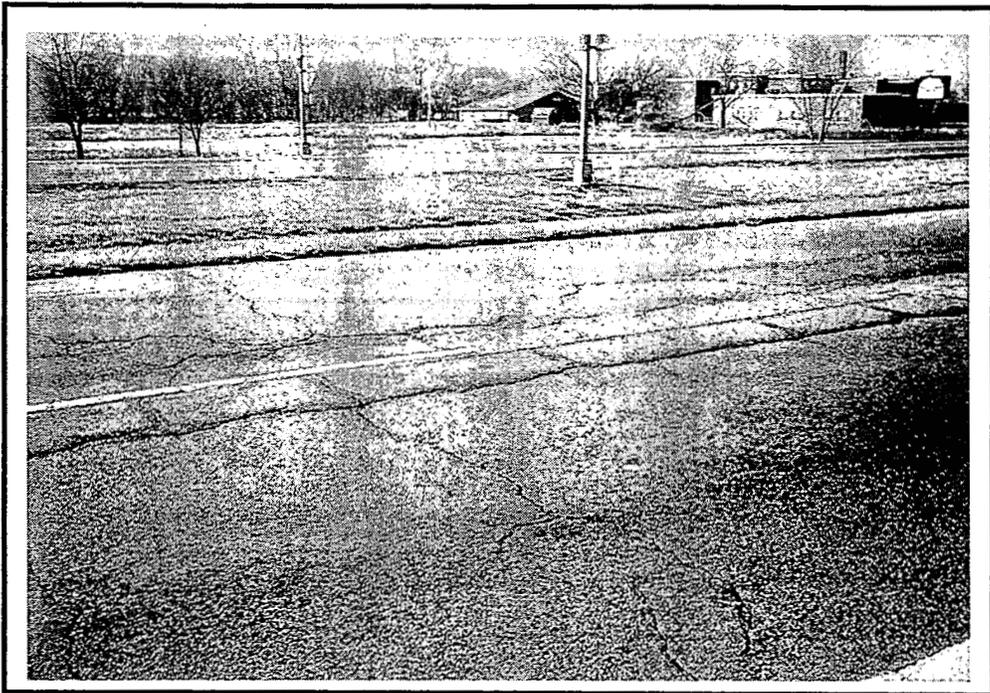


Photo B-21. Crack Sealing Deficiency, Unsealed Cracks

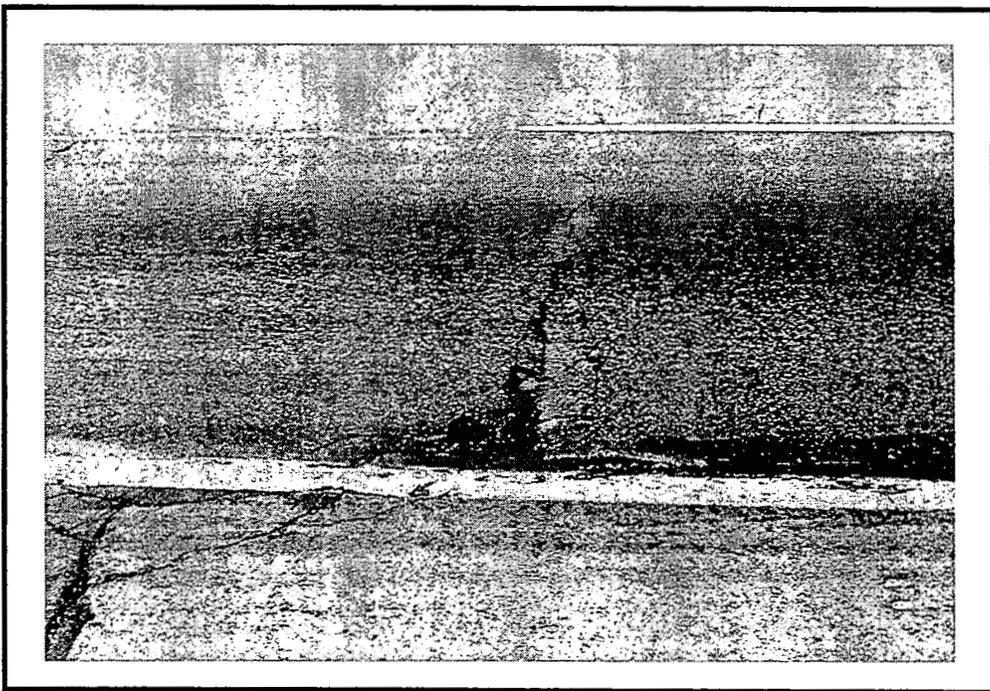
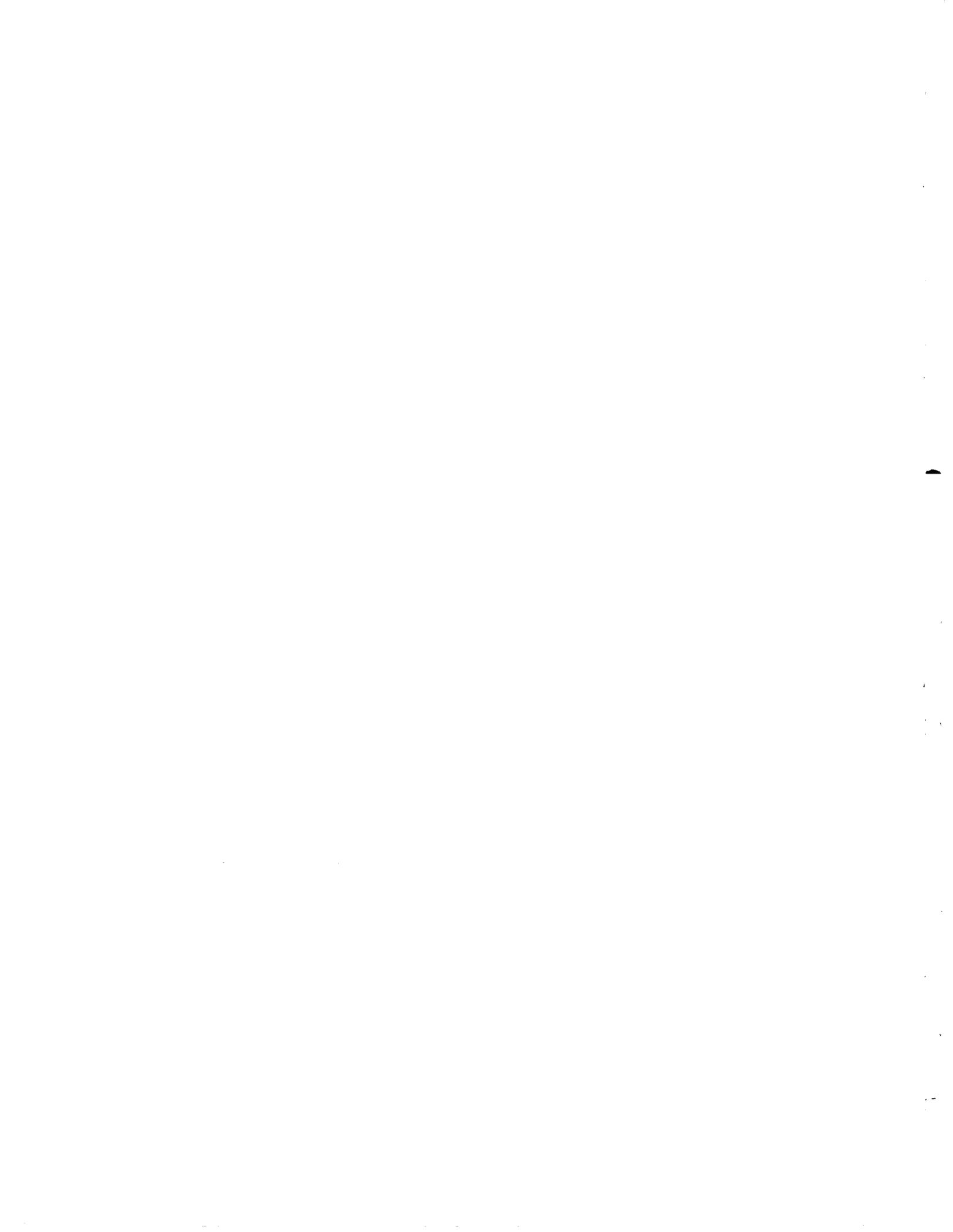


Photo B-22. Crack sealing Deficiency, Cracks not sealed properly







APPENDIX C

Description of Distresses in Jointed Reinforced Concrete or Jointed Concrete Pavements (JRC/JC Pavements)

JRC/JC PAVEMENT

Distress Type: **Surface Deterioration**

Description: Disintegration or loss of concrete from the surface of the pavement. Includes scaling and abrasion. Scaling is the flaking away of the concrete surface. Abrasion is similar to scaling in that a loss of fine, surface aggregate occurs. Abrasion is usually a result of weathering and traffic wear and is normally confined to the wheel track area.

Severity Level: **Low--** Aggregate visible.

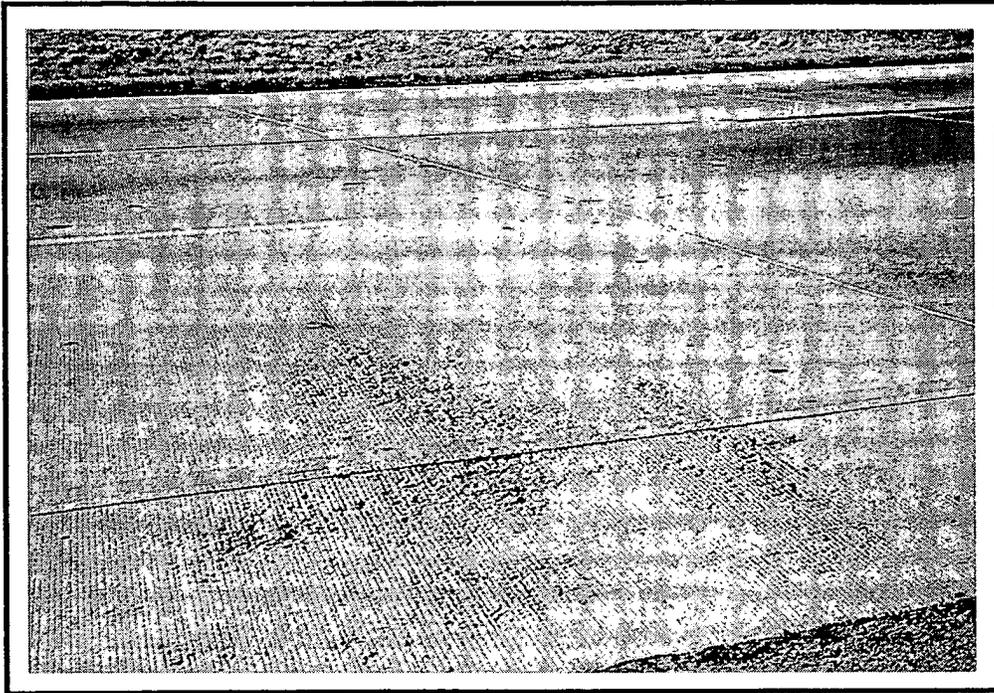
Medium-- Surface has an open texture and is moderately rough with considerable loss of fine aggregate and some coarse aggregate removed.

High-- Surface rough or pitted.

Extent Level: **Occasional--** Less than 20 percent of the surface area.

Frequent-- 20 to 50 percent of the surface area.

Extensive-- Equal to or greater than 50 percent of the surface area. This level includes continuous distress in both wheel tracks.



**Photo C-1. Surface Deterioration in Jointed Concrete Pavement,
Medium Severity**



**Photo C-2. Surface Deterioration in Jointed Concrete Pavement, High
Severity**

JRC/JC PAVEMENT

Distress Type:	Popouts
Description:	Cone shaped holes in the pavement surface with aggregates at the bottom and unrelated to joint or crack spalling. Aggregate quality is related to this type of distress. Popouts usually range from 25 to 100 mm (1 to 4 inches) in diameter and from 13 to 50 mm (½ to 2 inches) in depth.
Severity Level:	Severity levels are not considered.
Extent Level:	Occasional-- Less than 20 percent of the area is affected. Frequent-- 20 to 50 percent of the area is affected. Extensive-- More than 50 percent of the area is affected.

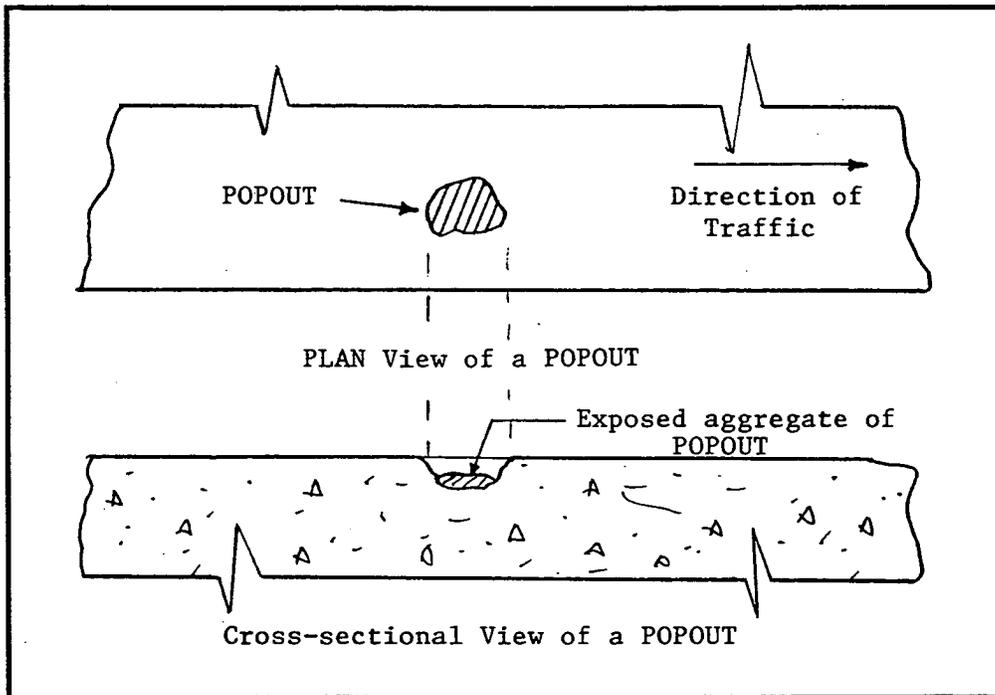


Photo C-3. Popout in a Concrete Pavement, Plan and Cross-sectional Views

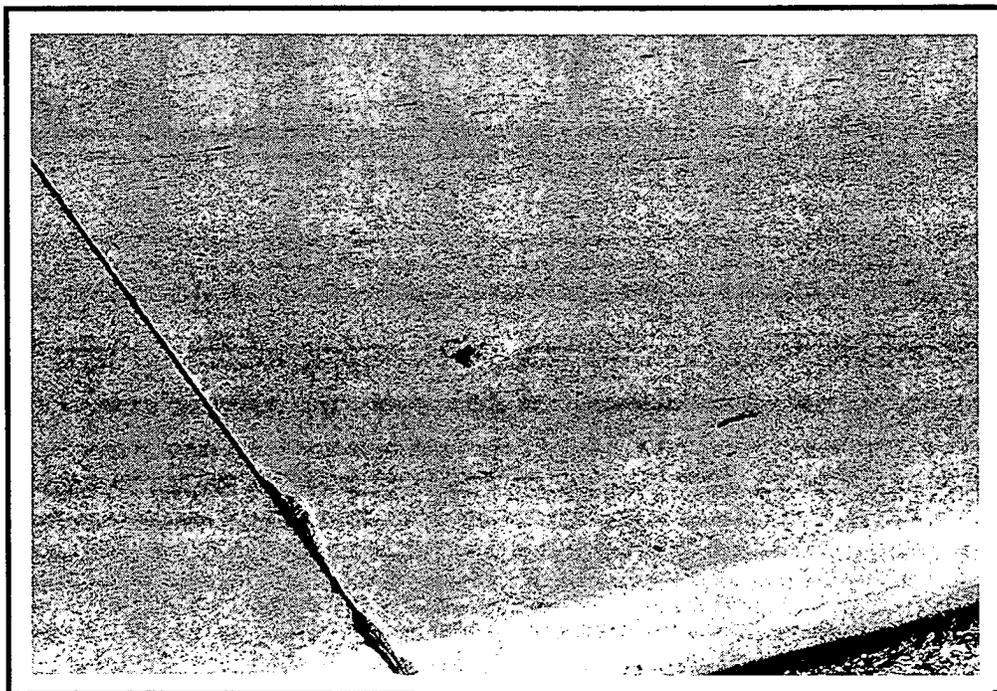


Photo C-4. Popouts in a Jointed Concrete Pavement

JRC/JC PAVEMENT

Distress Type: Patching

Description: Patching is either the placing of additional material on the surface of the existing pavement or the replacement of existing pavement in isolated areas.

Deductions shall be made for all patches present in the pavement which are made with asphalt concrete material and are the result of deterioration and/or maintenance since the last construction project.

No deductions shall be made for existing patches which consist of sound concrete. Where deterioration exists with a concrete repair, the deterioration shall be rated as part of the pavement.

Multiple patches found along a transverse joint or crack which do not interconnect shall be added together to represent the size of one patch.

Multiple patches found along a longitudinal joint or crack which do not interconnect, but are within the same slab, shall be added together to represent the size of one patch.

Severity Level: Low-- Patch size $< 0.1 \text{ m}^2$ (1 sq. ft.), and patches are not deteriorated.

Medium-- Patch size $< 0.1 \text{ m}^2$ (1 sq. ft.), with deterioration present.

High-- Patch size $> 0.1 \text{ m}^2$ (1 sq. ft.), regardless of deterioration.

Extent Level: Occasional-- < 10 patches/1.6 km (per mile).

Frequent-- 10 to 20 patches/1.6 km (per mile).

Extensive-- > 20 patches/1.6 km (per mile).

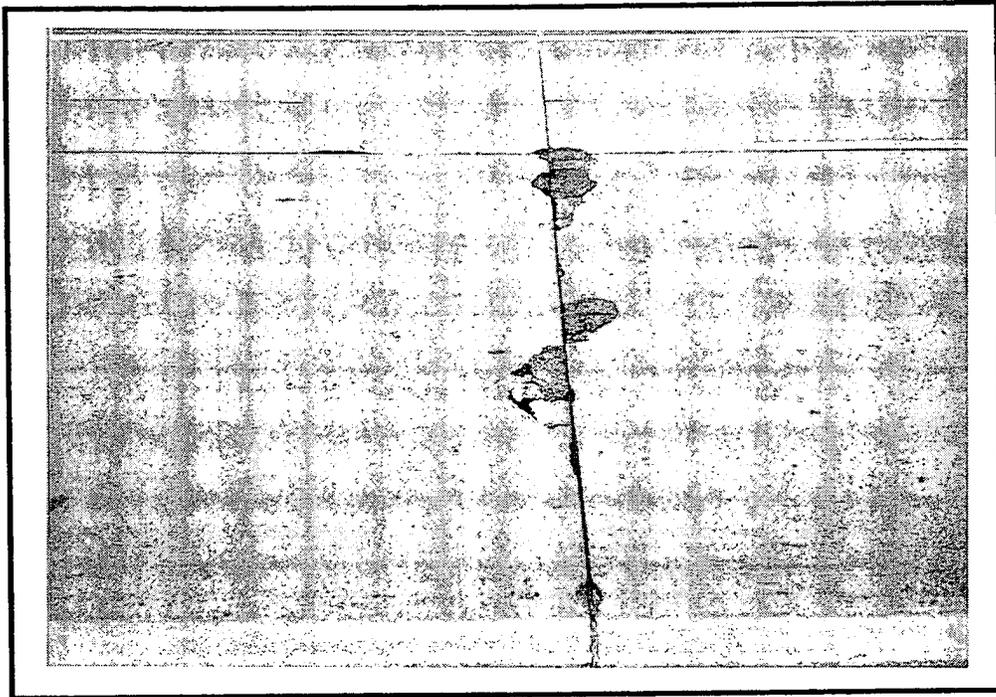


Photo C-5. Patching in Jointed Concrete Pavement, Low Severity

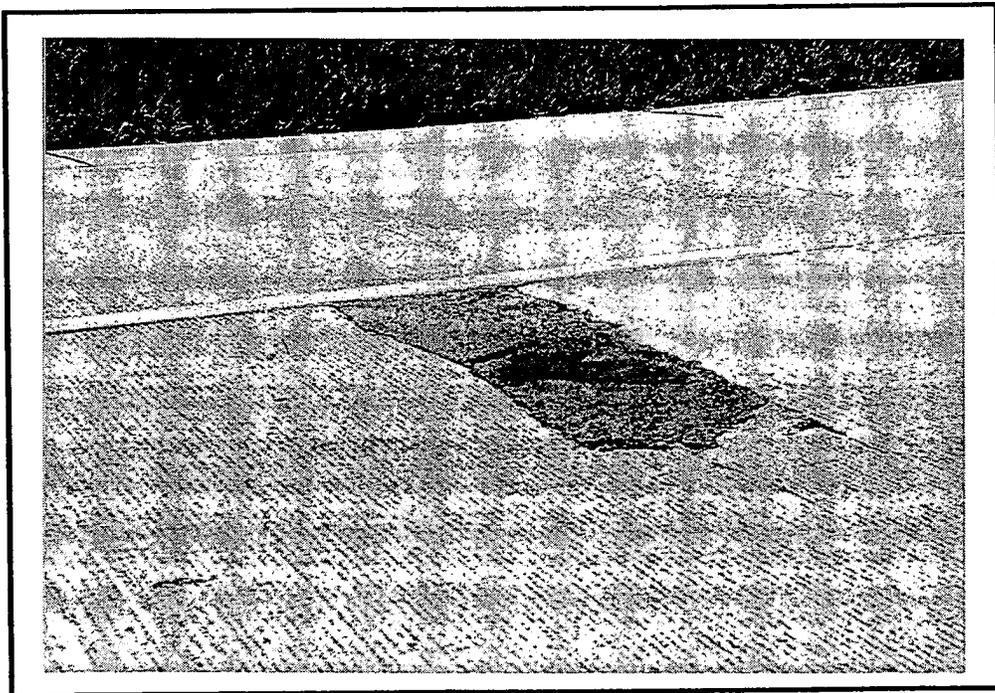


Photo C-6. Patching in Jointed Concrete Pavement, High Severity

JRC/JC PAVEMENT

Distress Type: **Pumping**

Description: Pumping is the ejection of fine soil particles through pavement cracks, joints, or along pavement edges. Pumping can be identified by the presence of surface staining and base or subgrade material near joints or cracks. Shoulder disintegration at the pavement edge is often an indicator of pumping beneath the slab.

Severity Level: Severity is based upon the rater's degree of certainty that pumping is occurring as indicated by visual evidence.

L & M-- Some staining of the surface around cracks or joints is noted. Rater is quite certain that pumping exists.

High-- Clear evidence that pumping exists. Excessive staining, medium severity or greater, faulting, corner breaks or punchouts. Rater is quite certain that pumping exists.

Extent Level: **Occasional--** Less than 10 of the joints and cracks exhibit pumping.

Frequent-- 10 to 25 percent of the joints and cracks exhibit pumping.

Extensive-- More than 25 percent of the joints and cracks exhibit pumping.



Photo C-7. Pumping in Jointed Concrete Pavement, High Severity

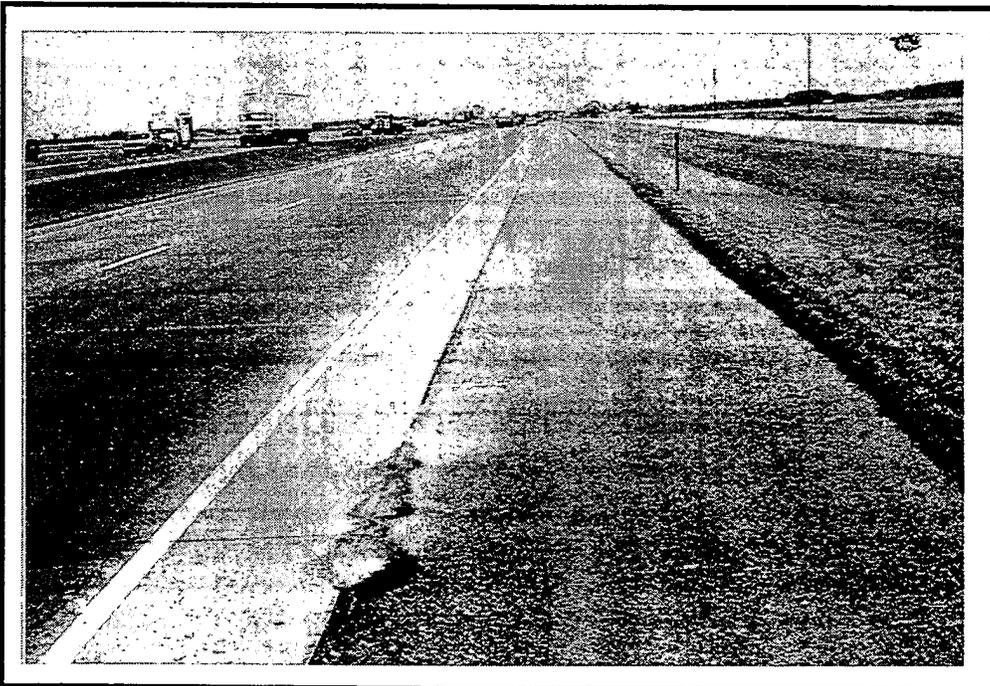


Photo C-8. Pumping in Jointed Concrete Pavement, Low Severity

JRC/JC PAVEMENT

Distress Type: **Faulting**

Description: Faulting is the difference in elevation between abutting slabs at transverse joints or cracks. Faulting is usually caused by a pumping action of underlying fine grained materials, settlement of soft subgrade, or from curling or warping of slabs due to temperature and moisture gradients.

Note: If transverse cracks are faulted, write the letter "C" on the rating form. If both cracks and joints are faulted, write the letter "B". Otherwise, faulting indicates only joints.

Severity Level: Low-- Less than 6 mm (1/4 inch) fault.

 Medium— 6 mm to 13 mm (1/4 to 1/2 inch) fault.

 High-- Greater than 13 mm (1/2 inch) fault.

Extent Level: Occasional-- Faulting occurs along less than 20 percent of the joints and cracks.

 Frequent-- Faulting occurs along 20 to 50 percent of the joints and cracks.

 Extensive-- More than 50 percent of the joints and cracks are faulted.

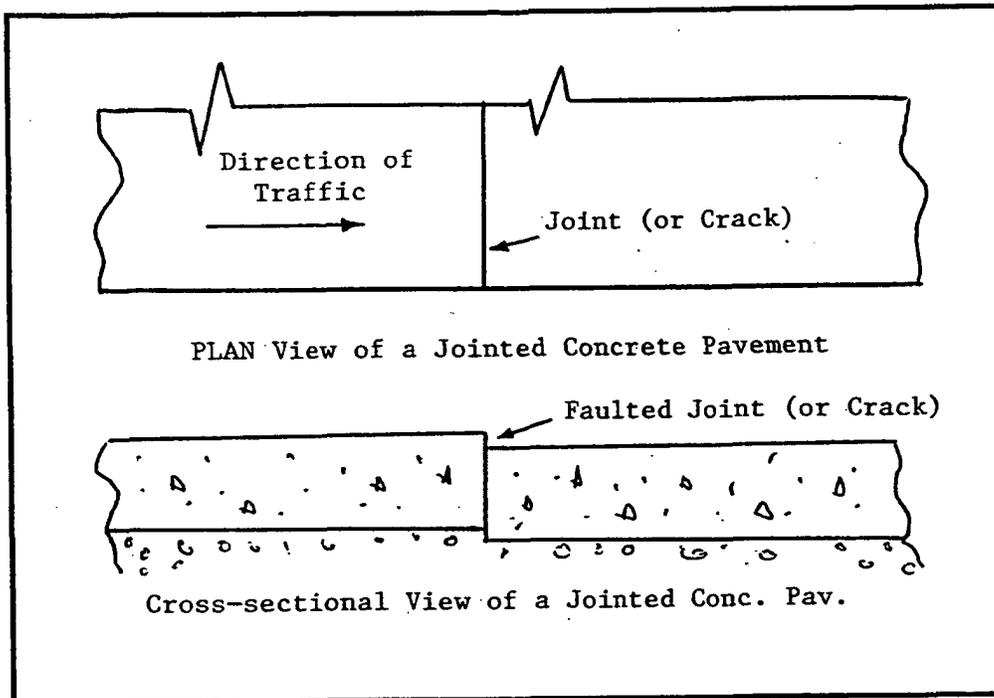


Photo C-9. Sketch showing Faulting in Jointed Concrete Pavement

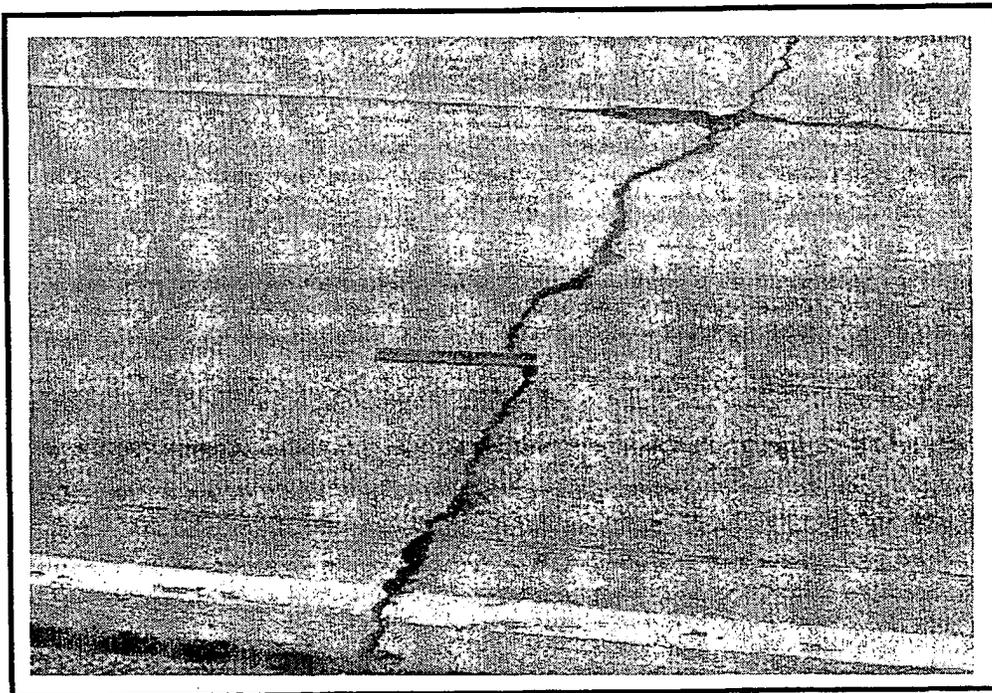


Photo C-10. Faulting in Jointed Concrete Pavement

JRC/JC PAVEMENT

Distress Type: Settlement

Description: Settlement is a dip or depression in the longitudinal profile of the pavement surface. Settlement should be considered a distress when it causes a noticeable effect upon riding quality.

Severity Level: Severity is based upon the effect of the settlement or waves upon ride quality and vehicle control when traveling along the roadway at 60 km/hour (40 MPH, step 1 of the monitoring procedure).

Low-- Noticeable effect upon ride, driver able to maintain vehicle control easily.

Medium-- Some discomfort to passengers, driver able to maintain control with slight corrective action.

High-- Definite effect upon ride quality. Noticeable profile dips in settlement areas greater than 150 mm (6 inches). Waves cause rocking of vehicle similar to motion created at moderately faulted jointed crack pavements.

Extent Level: **Occasional--** Less than 2 settlement/1.6 km (per mile) of roadway.

Frequent-- 2 to 4 settlement areas/1.6 km (per mile) of roadway.

Extensive-- More than 4 settlements/1.6 km (per mile) of roadway.

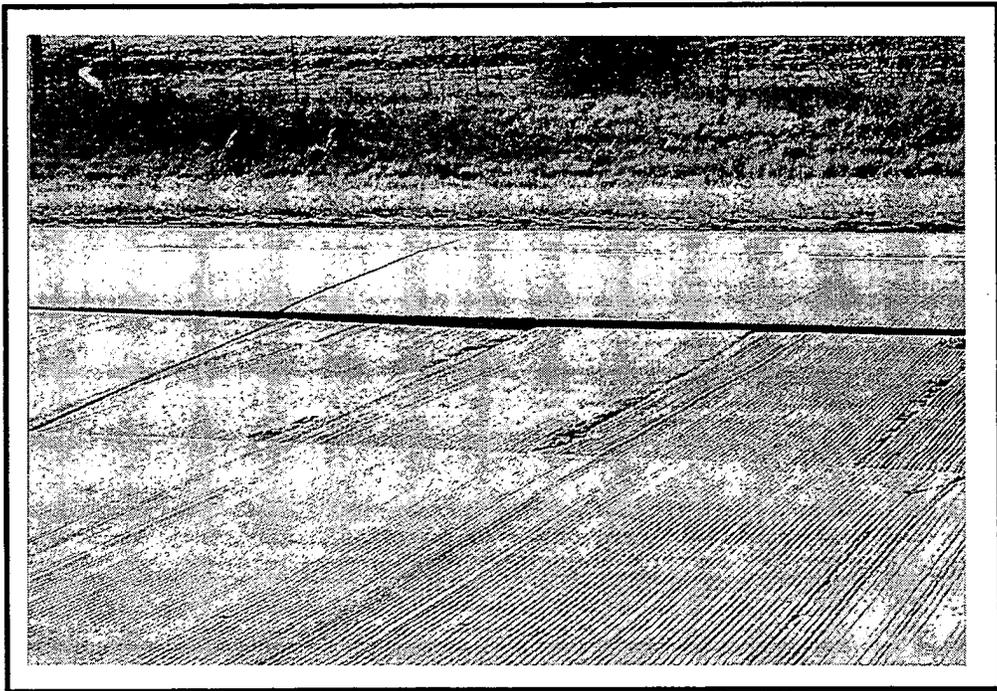


Photo C-11. Settlements in Jointed Concrete Pavement, Medium Severity

JRC/JC PAVEMENT

Distress Type: Transverse Joint Spalling

Description: Joint spalling is the break up or disintegration of the concrete at longitudinal or transverse pavement joints. A spall normally does not extend vertically through the slab but rather intersects the joint at an angle. Often joint spalling is the result of durability ("D") cracking of the pavement. The rater is asked to indicate on the rating form if the joint spalling is a result of "D" cracking. Durability ("D") cracking is a series of fine crescent-shaped cracks in the concrete surface which usually runs parallel to a joint or major crack and curve across slab corners. Cracking pattern is normally concave in relation to slab corners or joints. D-cracking can eventually lead to disintegration and spalling of the concrete near the joints or corners of the slab.

Severity Level: Low-- Spalls less than 100 mm (4 inches) wide, measured to the center of the joint, with loss of material, or spalls with no loss of material and no patching.

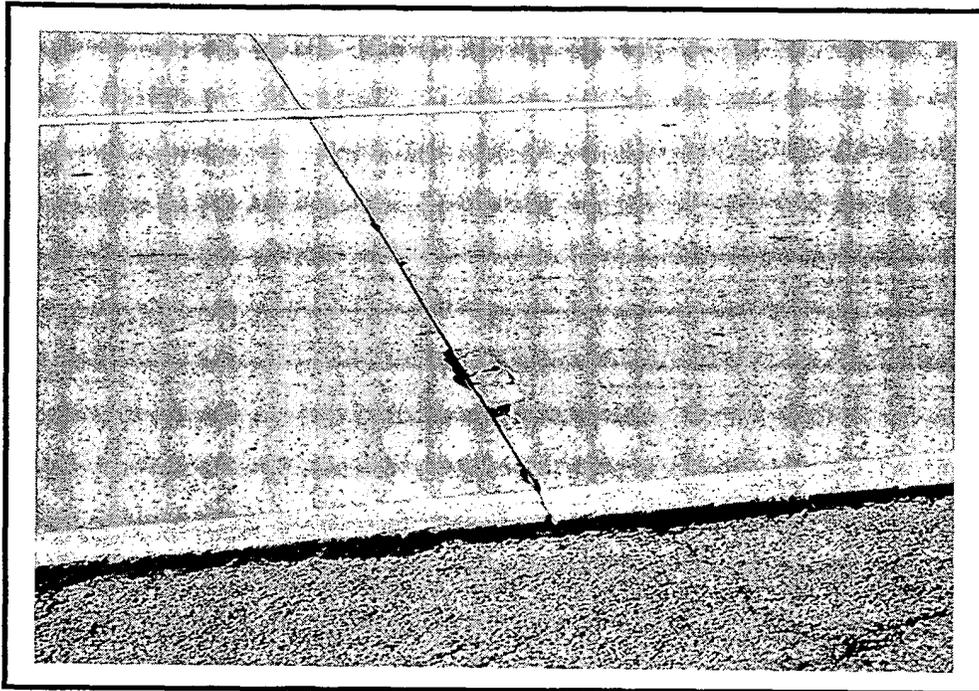
Medium-- spalls 100 mm to 225 mm (4 to 9 inches) wide, measured to the center of the joint, with loss of material.

High-- Spalls greater than 225 mm (9 inches) wide, measured to the center of the joint, with loss of material.

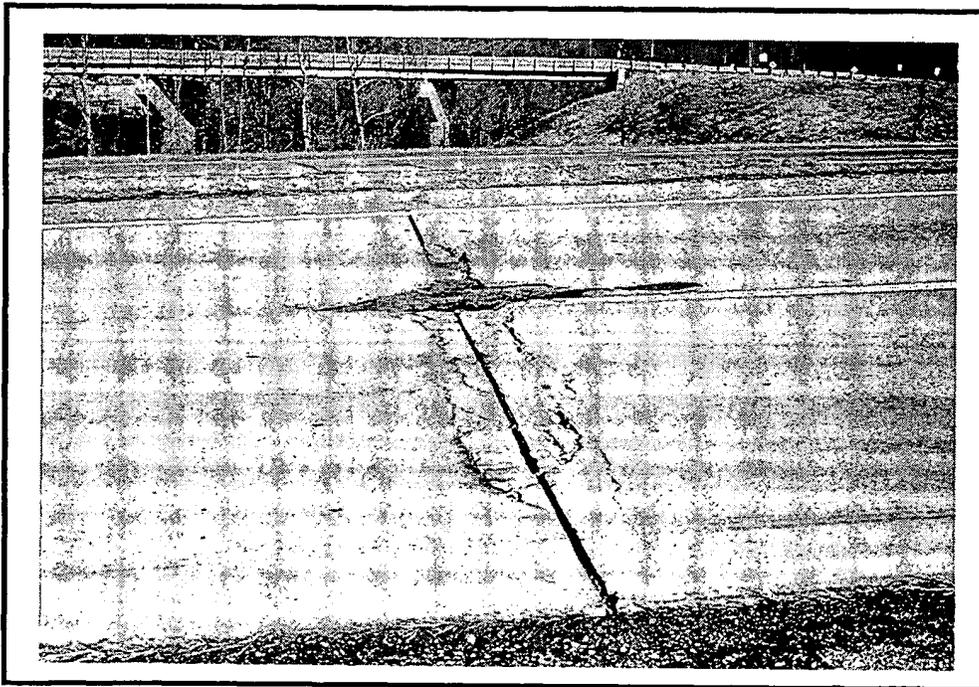
Extent Level: Occasional-- Less than 25 percent of the transverse joints are spalled.

Frequent-- 25 to 75 percent of the transverse joints are spalled.

Extensive-- More than 75 percent of the transverse joints are spalled.



**Photo C-12. Transverse Joint Spalling in Jointed Concrete Pavement,
Low Severity**



**Photo C-13. Transverse Joint Spalling in Jointed Concrete Pavement,
High Severity**

JRC/JC PAVEMENT

Distress Type: **Joint Sealant Damage**

Description: Joint sealant damage is any deterioration of the sealant which permits water or incompressibles to enter the joint. Damage includes disintegration, removal, pull out, hardening or debonding of the joint material from the adjoining slab edge.

Severity Level: Severity levels are not considered for this distress.

Extent Level: **Occasional--** Less than 20 percent of the joints are not effectively sealed.
Frequent-- 20 and 50 percent of the joints are not effectively sealed.
Extensive-- Greater than 50 percent of the joints are not effectively sealed.

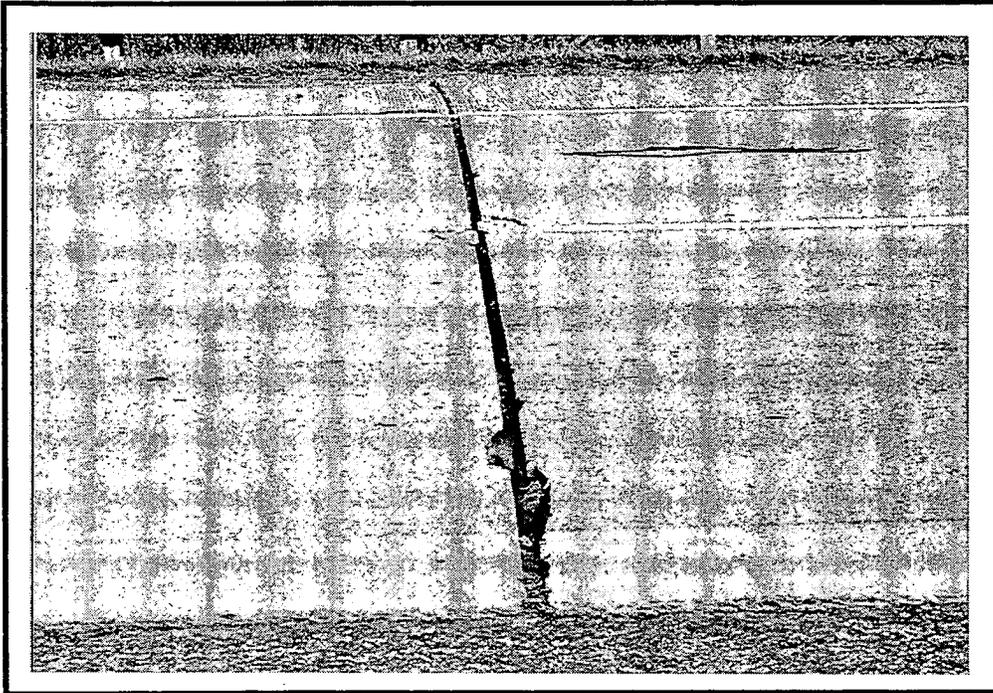


Photo C-14. Joint Sealant Damage in Jointed Concrete Pavement

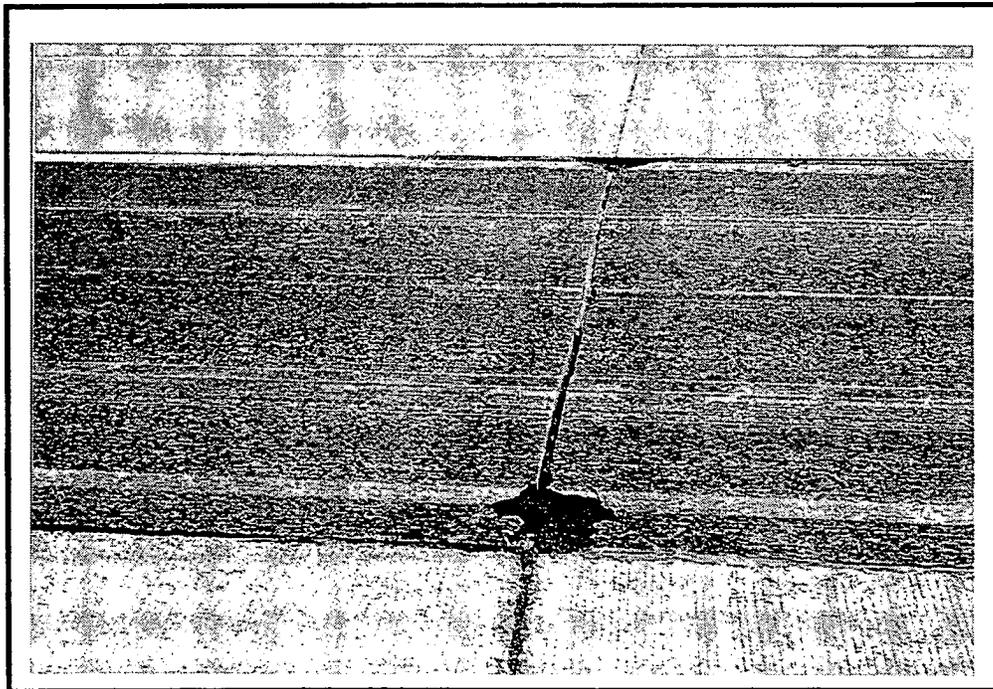


Photo C-15. Joint Sealant Damage in Jointed Concrete Pavement

JRC/JC PAVEMENT

Distress Type: Pressure Damage

Description: Pressure damage may be spalling, crushing, or upheaval at transverse joints or cracks resulting from expansion of the concrete layer. Pressure induced spalling is differentiated from other joint spalling by the shape of the spalled area. Pressure spalls are usually 150 to 300 mm (6 to 12 inches) long measured from the crack or joint and up to 300 mm (12 inches) wide.

Severity Level: Separate severity levels for pressure damage spalling are not defined. All pressure damage spalling is considered severe since this distress may be a predictor or more serious pressure distress (blow ups).

Extent Level: Extent is based upon the number of transverse joints which exhibit pressure damage spalling.

Occasional-- Less than 1/1.6 km (per mile).

Frequent-- Between 1 and 3/1.6 km (per mile).

Extensive-- More than 3/1.6 km (per mile).

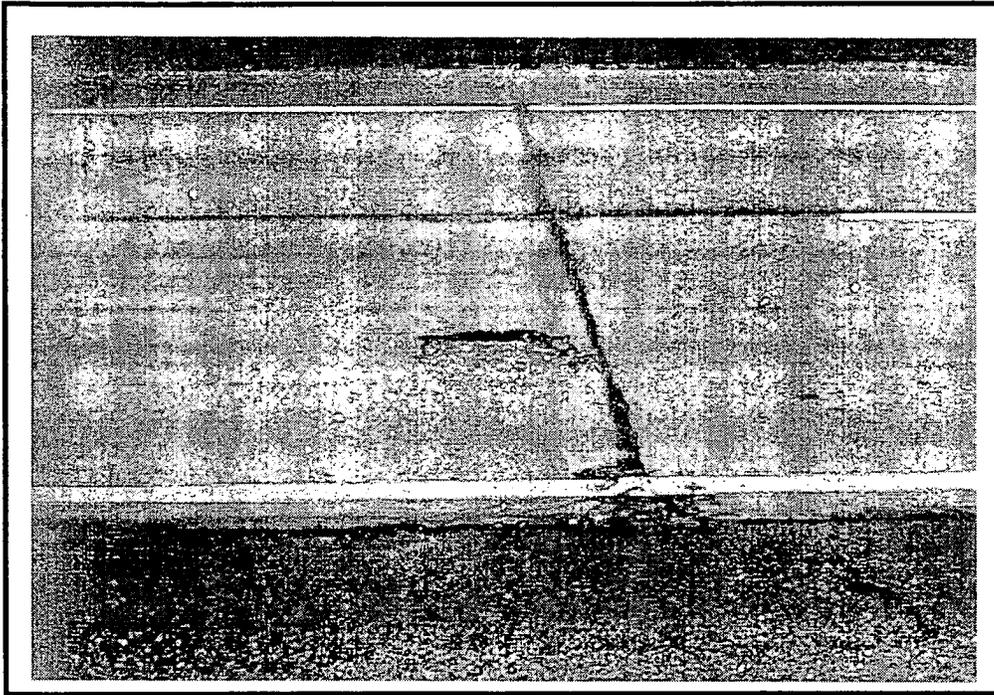


Photo C-16. Pressure Damage in Jointed Concrete Pavement



Photo C-17. Pressure Damage in Jointed Concrete Pavement

JRC/JC PAVEMENT

Distress Type: Transverse Cracking

Description: A crack or break at approximately right angles to the pavement centerline. Some transverse cracks (hairline shrinkage cracks) are expected in reinforced concrete pavements which have large transverse joint spacing. Additional transverse cracking could be caused by repeated heavy traffic loading, thermal and moisture gradients and subgrade settlement or consolidation.

Severity Level:

Low--	Hairline or tight with little crack spalling.
Medium--	Crack opened or spalled at the surface to a width of 6 mm to 25 mm (1/4 inch to 1 inch) over a distance equal to at least one-half the crack length.
High--	Crack opened or spalled at the surface to a width greater than 25 mm (1 inch) over a distance equal to at least one-half the crack length.

Extent Level: Extent level is based upon average crack spacing (CS) between intermediate transverse cracks as given by the following expression:

$$CS = L / (Z + 1)$$

where:

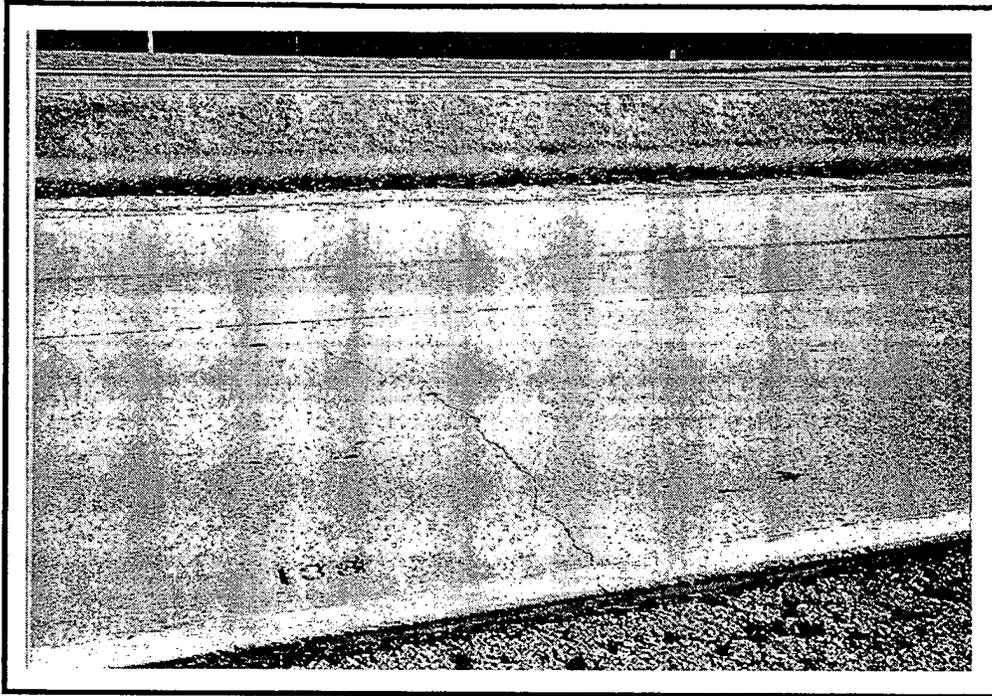
CS	= average crack spacing, m (ft),
Z	= average number of transverse cracks per panel, and
L	= transverse joint spacing, m (ft).

Average CS is based upon step 2 observations.

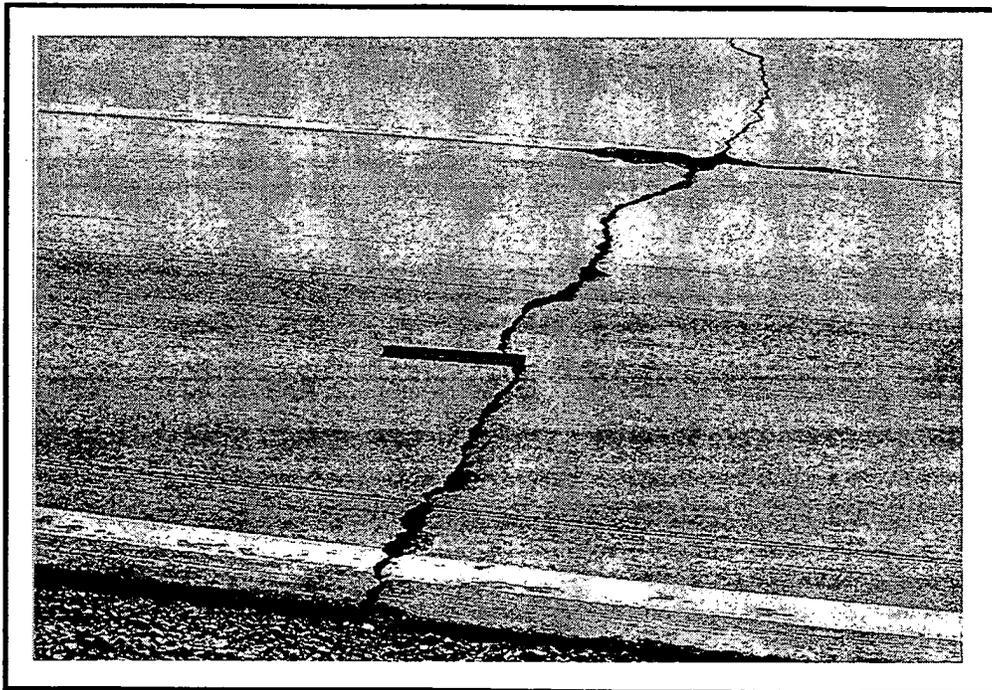
Occasional-- CS > 4.5 m (15 ft).

Frequent-- 3 m (10 ft) < CS < 4.5 m (15 ft).

Extensive-- CS < 3 m (10 ft).



**Photo C-18. Transverse Cracking in Jointed Concrete Pavement,
Low Severity**



**Photo C-19. Transverse Cracking in Jointed Concrete Pavement,
High Severity**

JRC/JC PAVEMENT

Distress Type: Longitudinal Cracking

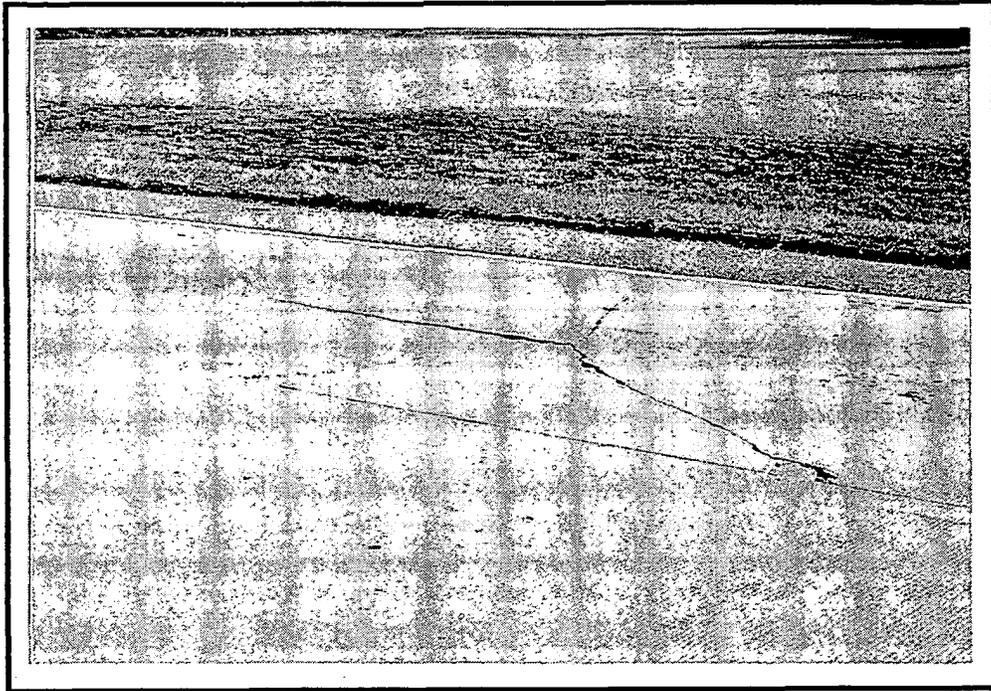
Description: A crack or break approximately parallel to the pavement centerline. This type of cracking is usually associated with subgrade settlement or insufficient bearing support.

Severity Level:

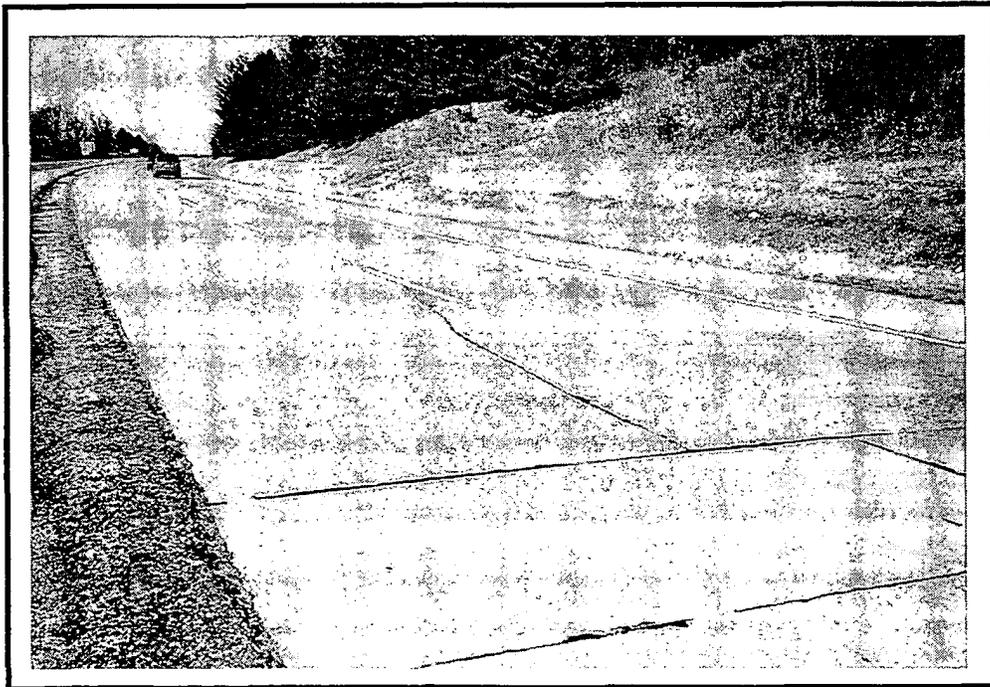
- Low-- Hairline or tight cracks with little crack spalling.
- Medium-- Crack opened or spall at the surface to a width of 6 mm to 25 mm (1/4 inch to 1 inch) over a distance equal to at least one-half the crack length.
- High-- Crack opened or spalled at the surface to a width greater than 25 mm (1 inch) over a distance equal to at least one-half the crack length.

Extent Level:

- Occasional-- Less than 5 percent of the slabs have longitudinal cracking.
- Frequent-- Between 5 and 20 percent of the slabs have longitudinal cracking.
- Extensive-- More than 20 percent of the slabs have longitudinal cracking.



**Photo C-20. Longitudinal Cracking in Jointed Concrete Pavement,
Medium Severity**



**Photo C-21. Longitudinal Cracking in Jointed Concrete Pavement,
Medium Severity**

JRC/JC PAVEMENT

Distress Type: **Corner Breaks**

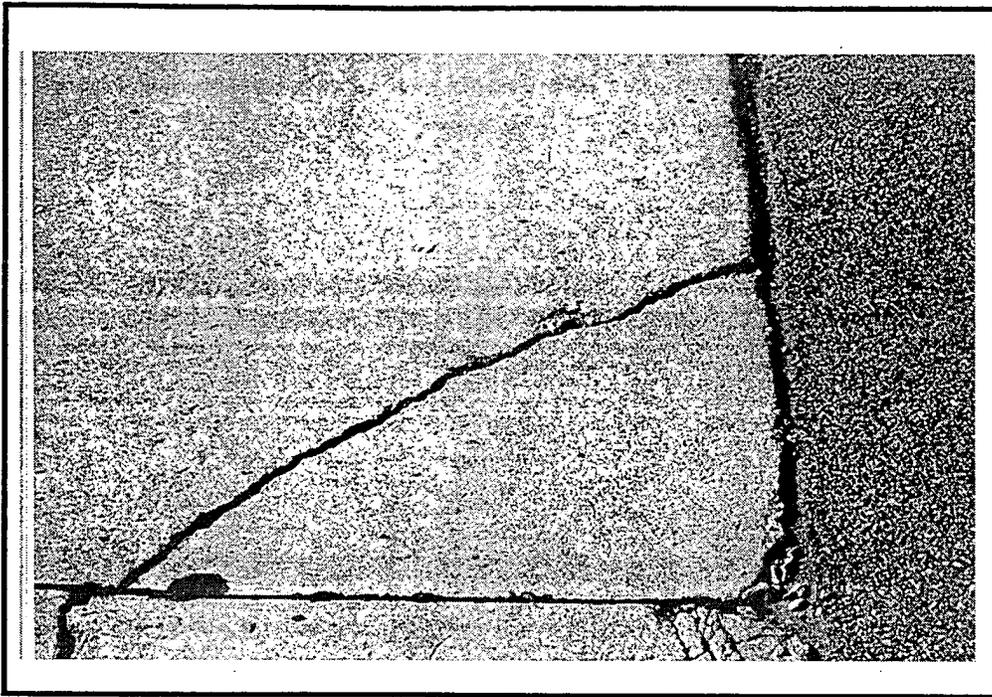
Description: A corner break is a crack that intersects transverse joints or cracks and a longitudinal edge diagonally. The leg size of the triangular break is usually greater than 300 mm (12 inches). Corner breaks can be differentiated from spalling by: (1) corner breaks extend vertically through the entire slab whereas spalls are only partial depth cracks, and (2) the triangle formed by a corner break is usually much larger than that of a spall.

Severity Level:

Low--	Crack width less than 6 mm (1/4 inch) with no spalling or settlement of the broken area.
Medium--	Crack width between 6 mm to 25 mm (1/4 inch to 1 inch) with some spalling and minor settlement of the broken area.
High--	Crack width greater than 25 mm (1 inch) and/or much spalling and settlement of the broken area. High severity may also be identified by shattering of the broken area by formation of smaller pieces within the corner break area.

Extent Level:

Occasional--	Less than 4 corner breaks/1.6 km (per mile).
Frequent--	4 and 10 corner breaks/1.6 km (per mile).
Extensive--	More than 10 corner breaks/1.6 km (per mile).



**Photo C-22. Corner Break in Jointed Concrete Pavement,
Medium Severity**

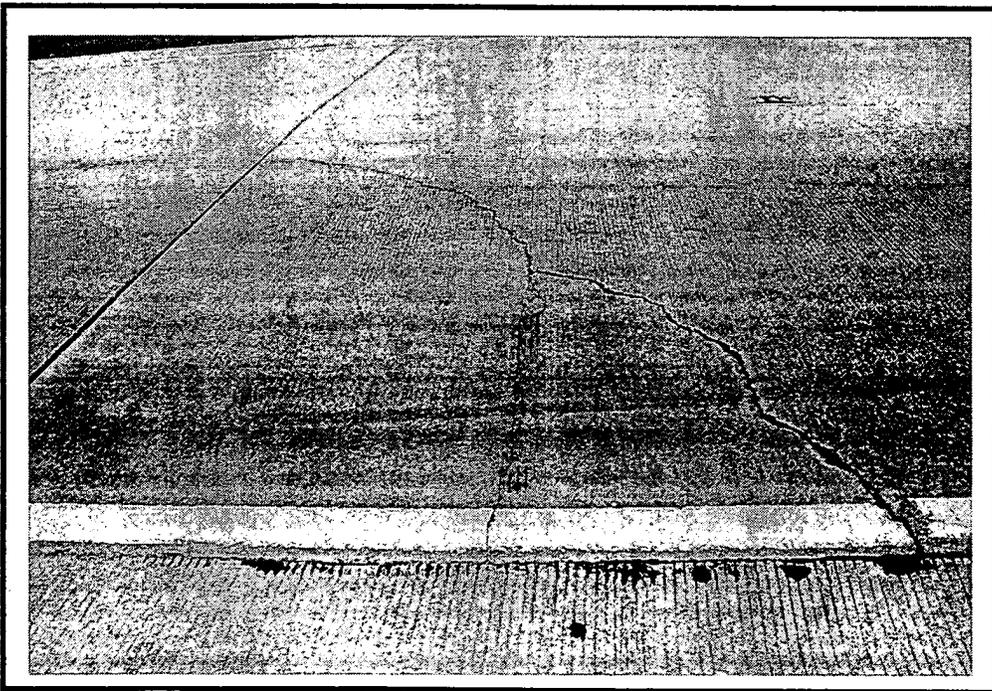


Photo C-23. Corner Breaks in Jointed Concrete Pavement, High Severity



APPENDIX D

**Description of Distresses in
Continuously Reinforced Concrete Pavements (CRCP)**

CRC PAVEMENT

Distress Type: Surface Deterioration

Description: Disintegration or loss of concrete from the surface of the pavement. Includes scaling and abrasion. Scaling is the flaking away of the concrete surface. Abrasion is similar to scaling in that a loss of fine, surface aggregate occurs. Abrasion is usually a result of weathering and traffic wear and is normally confined to the wheel track area.

Severity Level:

Low--	Aggregate visible.
Medium--	Surface has an open texture and is moderately rough with considerable loss of fine aggregate and some coarse aggregate removed.
High--	Surface rough or pitted.

Extent Level:

Occasional--	Less than 20 percent of the surface area.
Frequent--	20 to 50 percent of the surface area.
Extensive--	Equal to or greater than 50 percent of the surface area. This level includes continuous distress in both wheel tracks.

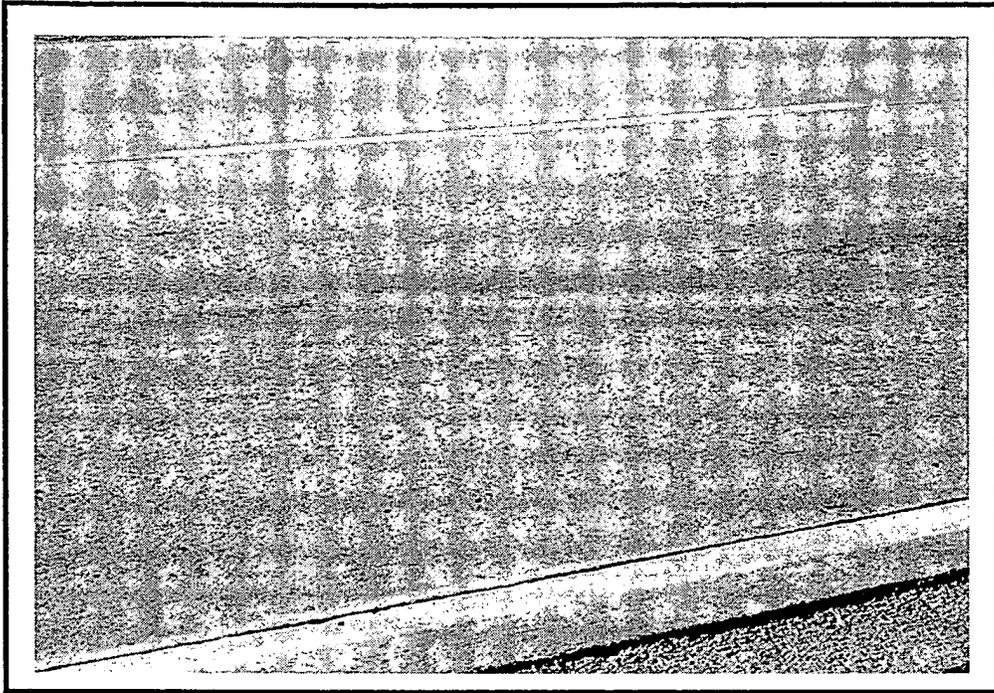


Photo D-1. Surface Deterioration in CRC Pavement, Medium Severity

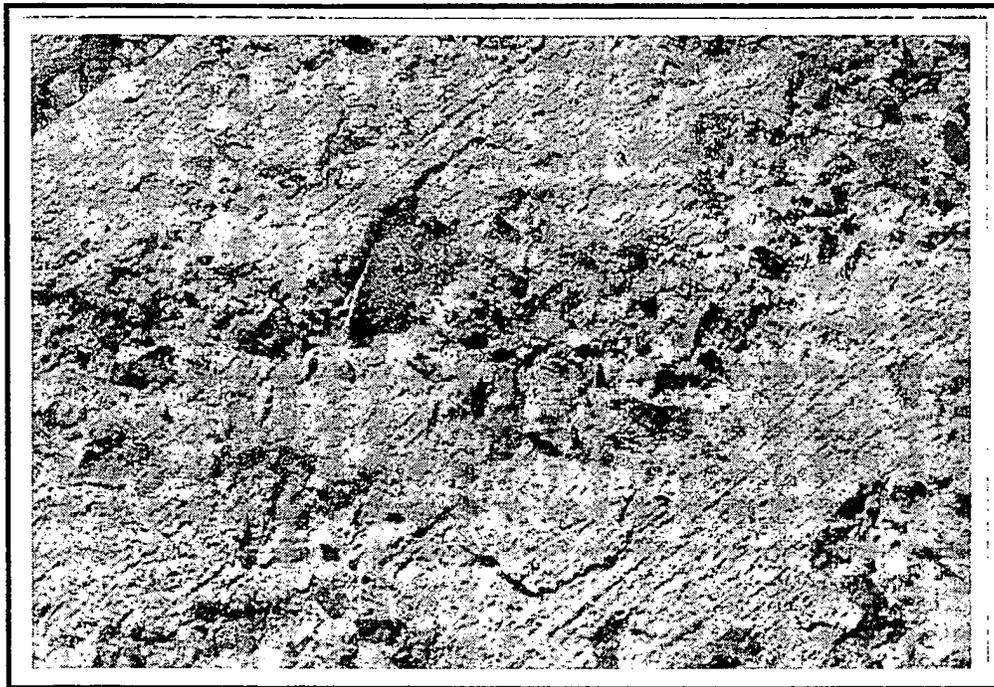


Photo D-2. Surface Deterioration in CRC Pavement, High Severity

CRC PAVEMENT

Distress Type: Popouts

Description: Cone shaped holes in the pavement surface with aggregates at the bottom and unrelated to joint or crack spalling. Aggregate quality is related to this type of distress. Popouts usually range from 25 to 100 mm (1 to 4 inches) in diameter and from 13 to 50 mm ($\frac{1}{2}$ to 2 inches) in depth.

Severity Level: Severity levels are not considered.

Extent Level:

- Occasional-- Less than 20 percent of the area is affected.
- Frequent-- 20 to 50 percent of the area is affected.
- Extensive-- More than 50 percent of the area is affected.

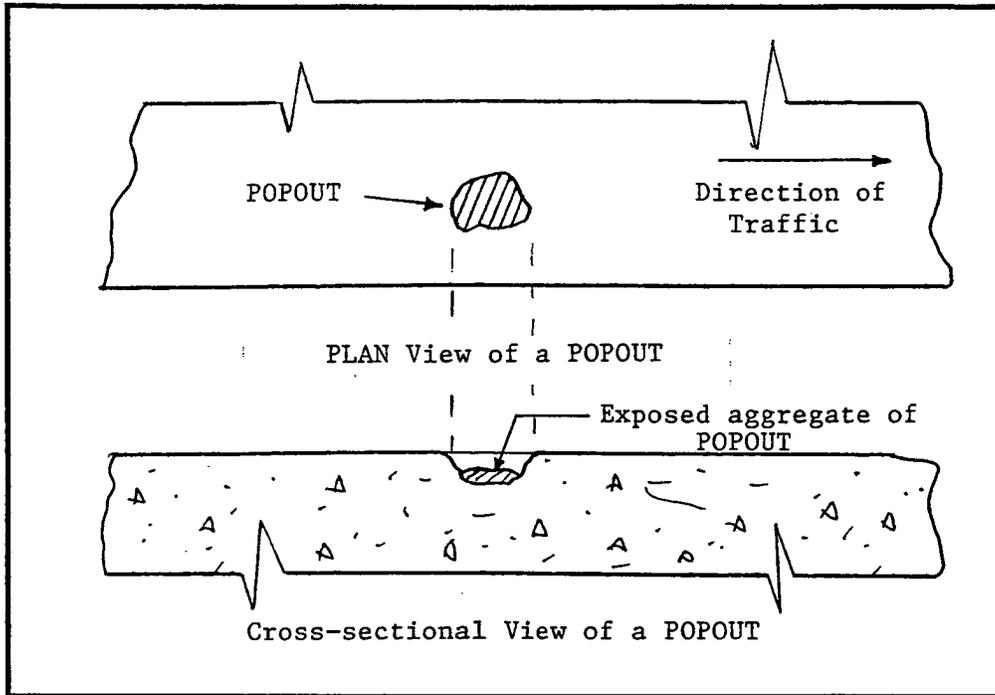


Photo D-3. Popout in CRC Pavement, Plan and Cross-section Views

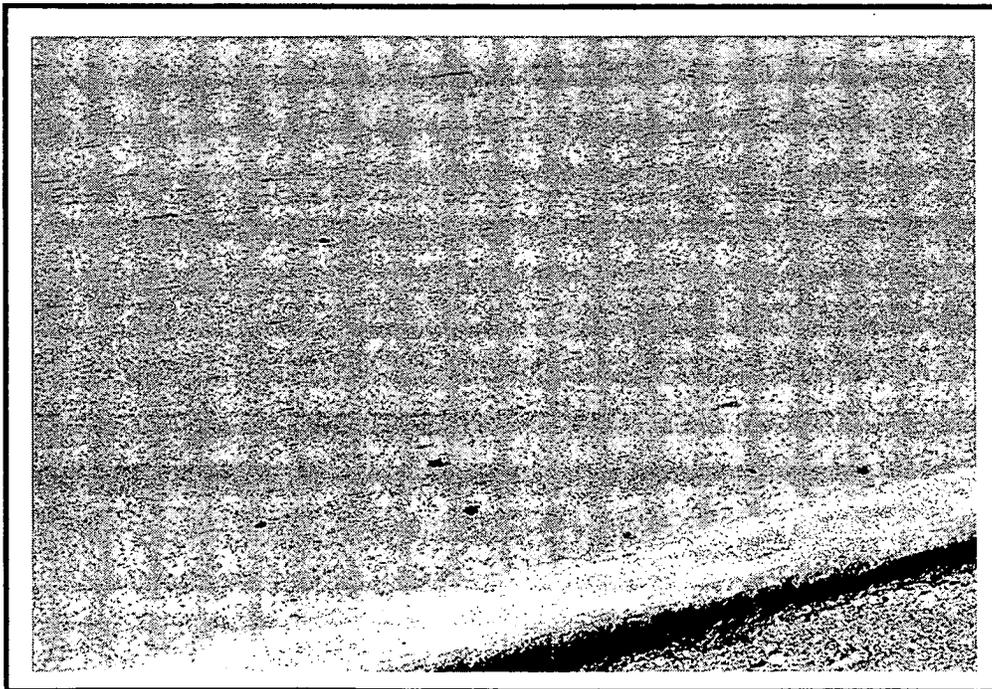


Photo D-4. Popouts in CRC Pavement

CRC PAVEMENT

Distress Type: **Patching**

Description: Patching is either the placing of additional material on the surface of the existing pavement or the replacement of existing pavement in isolated areas.

Deductions shall be made for all patches present in the pavement which are made with asphalt concrete material and are the result of deterioration and/or maintenance since the last construction project.

No deductions shall be made for existing patches which consist of sound concrete. Where deterioration exists with a concrete repair, the deterioration shall be rated as part of the pavement.

Multiple patches found along a transverse joint or crack which do not interconnect shall be added together to represent the size of one patch.

Multiple patches found along a longitudinal joint or crack which do not interconnect, but are within the same slab, shall be added together to represent the size of one patch.

Severity Level: **Low--** Patch size $<0.1 \text{ m}^2$ (1 sq. ft.), and patches are not deteriorated.

Medium-- Patch size $<0.1 \text{ m}^2$ (1 sq. ft.), with deterioration present.

High-- Patch size $>0.1 \text{ m}^2$ (1 sq. ft.), regardless of deterioration.

Extent Level: **Occasional--** <10 patches/1.6 km (per mile).

Frequent-- 10 to 20 patches/1.6 km (per mile).

Extensive-- >20 patches/1.6 km (per mile).

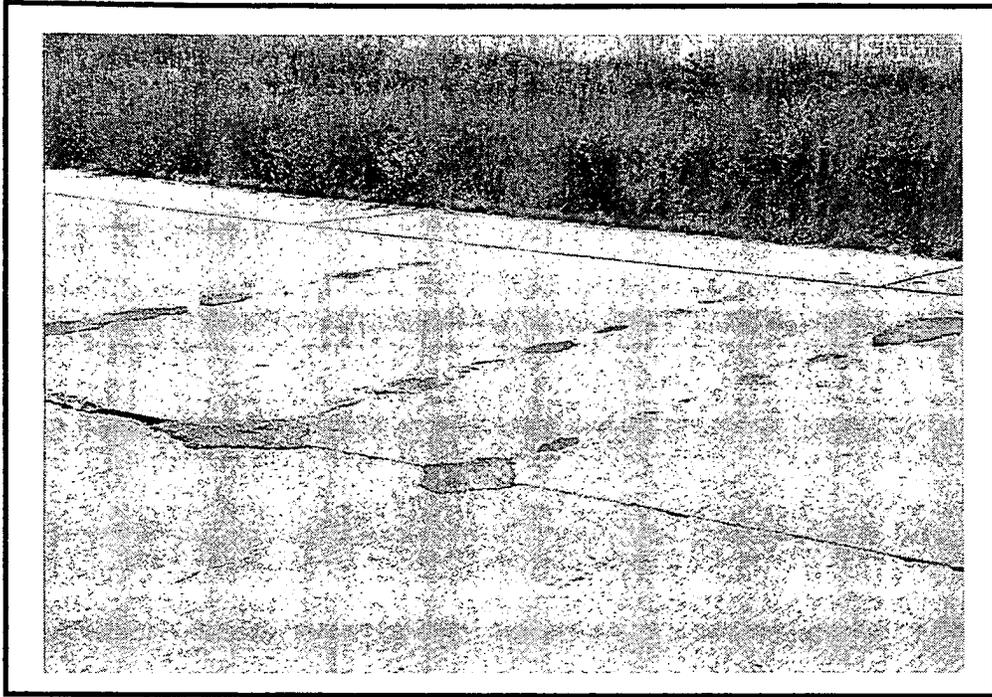


Photo D-5. Patching in CRC Pavement, Low Severity

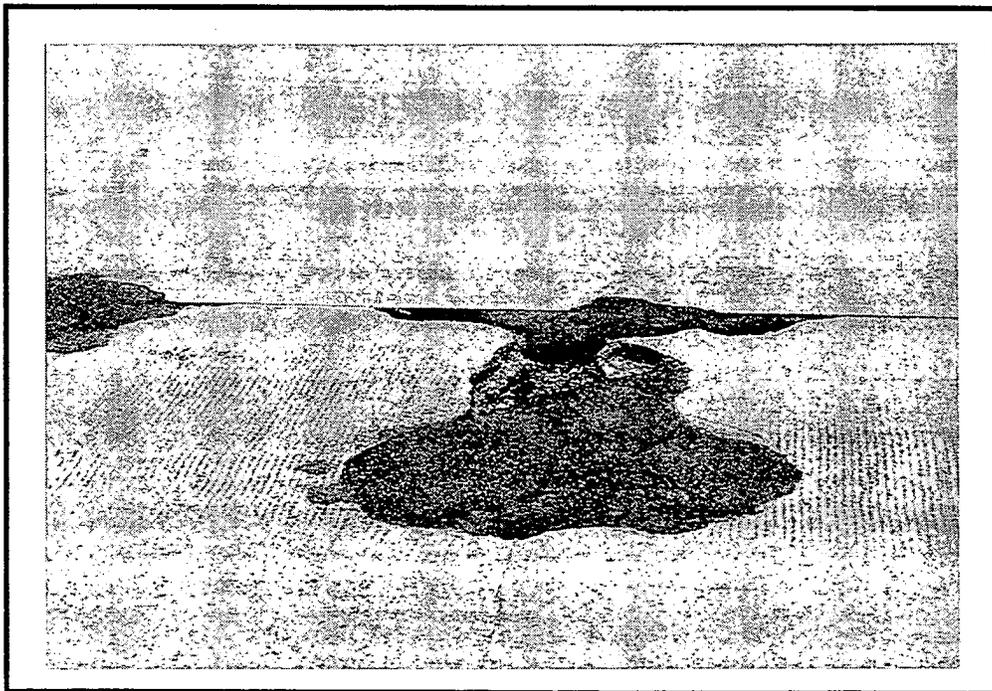


Photo D-6. Patching in CRC Pavement, High Severity

CRC PAVEMENT

Distress Type: **Pumping**

Description: Pumping is the ejection of fine soil particles through pavement cracks, joints, or along pavement edges. Pumping can be identified by the presence of surface staining and base or subgrade material near joints or cracks. Shoulder disintegration at the pavement edge is often an indicator of pumping beneath the slab.

Severity Level: Severity is based upon the rater's degree of certainty that pumping is occurring as indicated by visual evidence.

L & M-- Some staining of the surface around cracks or joints is noted. Rater is quite certain that pumping exists.

High-- Clear evidence that pumping exists. Excessive staining, medium severity or greater, faulting, corner breaks or punchouts. Rater is quite certain that pumping exists.

Extent Level: **Occasional--** Less than 10% of the joints and cracks exhibit pumping.

Frequent-- 10 to 25% of the joints and cracks exhibit pumping.

Extensive-- More than 25% of the joints and cracks exhibit pumping.

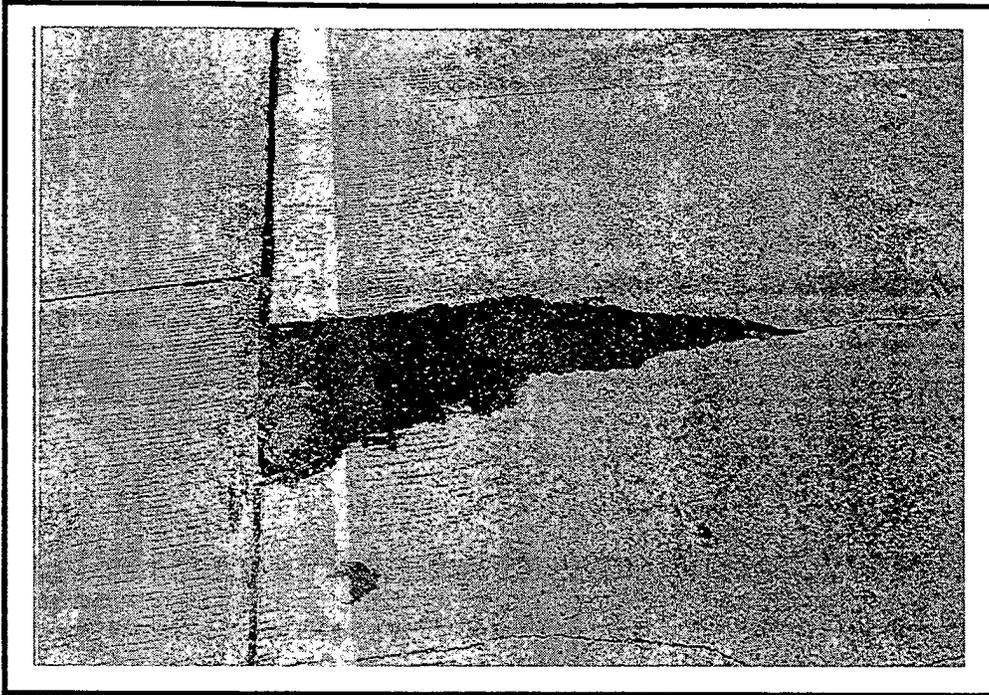


Photo D-7. Pumping in CRC Pavement, Medium Severity

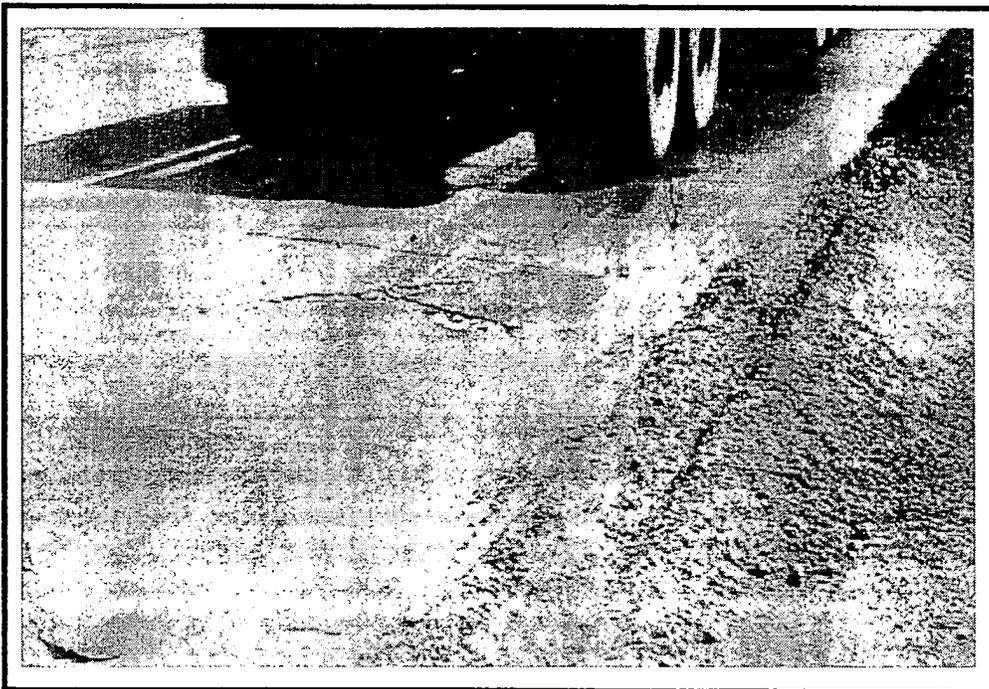


Photo D-8. Pumping, High Severity

CRC PAVEMENT

Distress Type: **Settlement and Waves**

Description: Because CRC pavements have short transverse crack spacing, these pavements can develop short waves or undulation as a result of poor support conditions, frost heave, or permanent deformation of the subgrade. Settlement is a dip or depression in the longitudinal profile of the pavement surface.

Severity Level: Severity is based upon the effect of the settlement or waves upon ride quality and vehicle control when traveling along the roadway at 60 km/hour (40 MPH, (step 1 of the monitoring procedure).

Low-- Noticeable effect upon ride, driver able to maintain vehicle control easily.

Medium-- Some discomfort to passengers, driver able to maintain control with slight corrective action.

High-- Definite effect upon ride quality. Noticeable profile dips in settlement areas greater than 150 mm (6 inches). Waves cause rocking of vehicle similar to motion created at moderately faulted jointed crack pavements.

Extent Level: Occasional-- Less than 2 settlements/1.6 km (per mile) of roadway and/or wave along less than 20 percent of the section length.

Frequent-- 2 to 4 settlement areas/1.6 km (per mile) of roadway and/or waves along 20 to 50 percent of the section length.

Extensive-- more than 4 settlement areas/1.6 km (per mile) of roadway and/or waves along more than 50 percent of the section length.

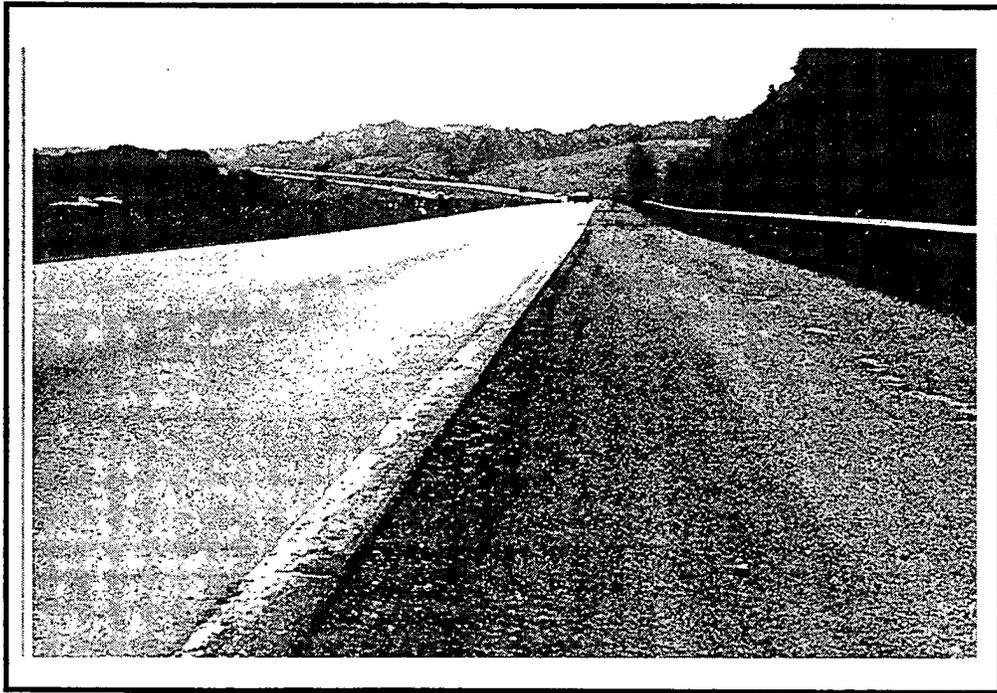


Photo D-9. Settlement in CRC Pavement

CRC PAVEMENT

Distress Type: **Transverse Crack Spacing**

Description: A crack at approximately right angles to the pavement centerline. Transverse cracking in CRC pavements is normal. The cracking is detrimental if the spacing is less than or greater than that associated with good CRC performance. Optimum CRC transverse crack spacing is about 1.5 m 2.4 m (5 to 8 feet).

Severity Level:

Low--	Average crack spacing greater than 1 m (3 feet).
Medium--	Average crack spacing less than 1 m (3 feet), with few intersecting cracks. Intersecting cracks are transverse cracks which do not cross the entire pavement width but intersect other transverse cracks.
High--	Average crack spacing less than 1 m (3 feet), with many intersecting cracks.

Extent Level: Extent is based upon the percentage of the section length having an undesirable transverse crack pattern.

Occasional-- Less than 20 percent.

Frequent-- 20 to 50 percent.

Extensive-- Greater than 50 percent.

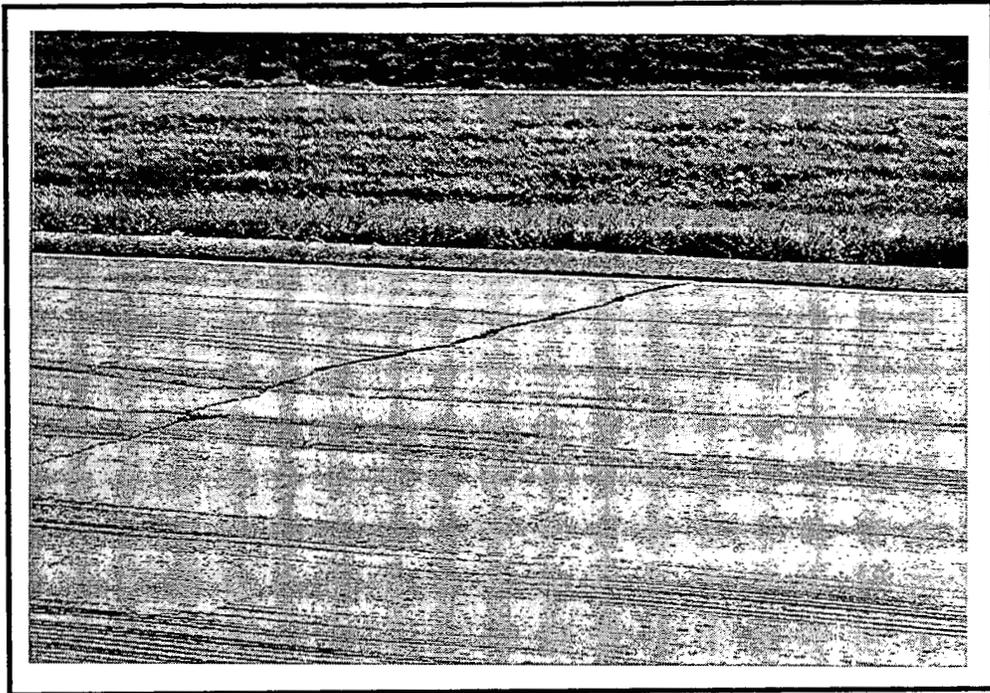


Photo D-10. Transverse Cracks in CRC Pavement, Low Severity



Photo D-11. Transverse Cracks in CRC Pavement, Medium Severity

CRC PAVEMENT

Distress Type: **Longitudinal Cracking**

Description: A crack or break approximately parallel to the pavement centerline. This type of cracking is usually associated with subgrade settlement or insufficient bearing support.

Severity Level: **Low--** Hairline or tight cracks with little crack spalling.

Medium-- Crack opened or spall at the surface to a width of 6 to 25 mm (1/4 inch to 1 inch) over a distance equal to at least one-half the crack length.

High-- Crack opened or spalled at the surface to a width greater than 25 mm (1 inch) over a distance equal to at least one-half the crack length.

Extent Level: **Occasional--** Longitudinal cracking occurs along less than 5 percent of the section length.

Frequent-- Longitudinal cracking occurs along from 5 to 15 percent of the section length.

Extensive-- Longitudinal cracking occurs along more than 15 percent of the section length.



Photo D-12. Longitudinal Cracking in CRC Pavement, Medium Severity

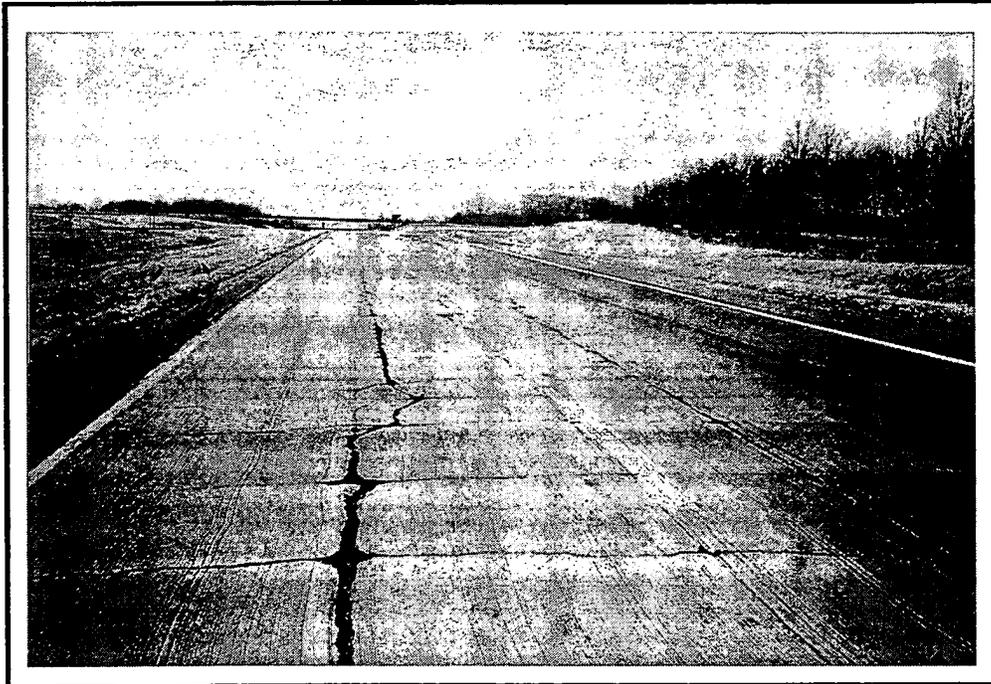


Photo D-13. Longitudinal Cracking in CRC Pavement, High Severity

CRC PAVEMENT

Distress Type: **Punchouts or Edge Breaks**

Description: A punchout or edge break is a cracked rectangular area usually along the outside pavement edge. A punchout requires formation of longitudinal crack (usually within the outer wheel track) which connects transverse cracks of the CRC pavement. The rectangular punchout area thus is defined by 2 transverse cracks, the longitudinal crack and the outside pavement edge. A punchout results from concrete that is over stressed because of short transverse crack spacing or poor support of the CRC pavement. Punchout areas which have been repaired should be evaluated for patching distress.

Severity Level: This distress is rated only for Medium and High levels.

Medium-- Crack width greater than 6 mm (1/4 inch) with some spalling. Punchout area may be depressed up to 13 mm (1/2 inch).

High-- Punchout area is depressed more than 13 mm (1/2 inch) and/or is breaking up or shattering.

Extent Level: **Occasional--** Fewer than 2 punchouts/1.6 m (per mile) of section length.

Frequent-- Between 2 and 5 punchouts/1.6 m (per mile) of section length.

Extensive-- More than 5 punchouts/1.6 m (per mile) of section length.

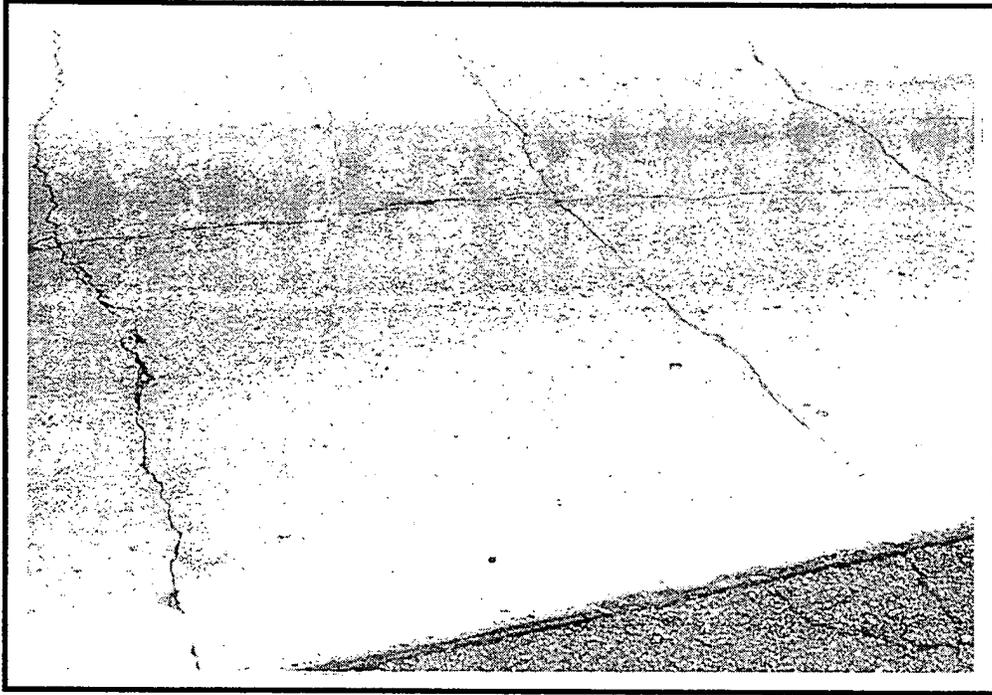


Photo D-14. Punchouts in CRC Pavement, Medium Severity

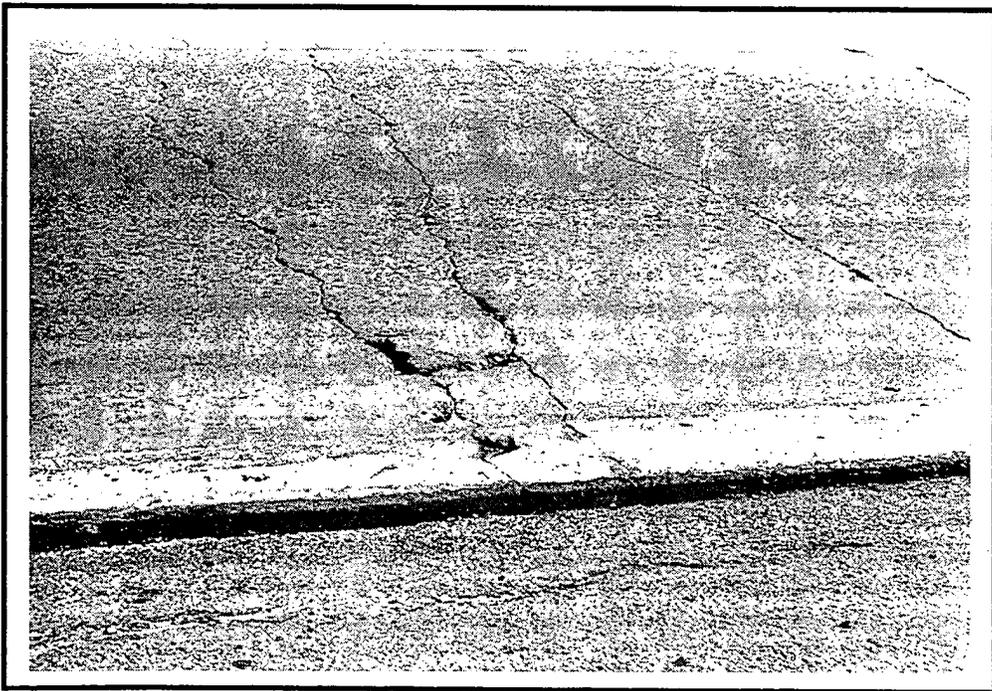


Photo D-15. Punchouts in CRC Pavement, High Severity

CRC PAVEMENT

Distress Type: Spalling

Description: Spalling in CRC pavements is the break up or disintegration of the concrete at transverse cracks. A spall normally does not extend vertically through the entire concrete layer but intersects the transverse crack at an angle. This distress may be caused by the presence of high percentage of reinforcing steel in the pavement.

Severity Level:

- Low-- < 25 mm (1"), missing pieces.
- Medium-- Distressed area 25 to 100 mm (1 - 4 inch) wide with most of the pieces missing.
- High-- Distressed areas more than 100 mm (4 inch) wide with some or most of the pieces missing.

Extent Level: Extent of this distress is based upon the percentage of transverse cracks which have spalled.

- Occasional-- Less than 20 percent of the cracks.
- Frequent-- Between 20 and 50 percent of the cracks.
- Extensive-- More than 50 percent of the cracks.

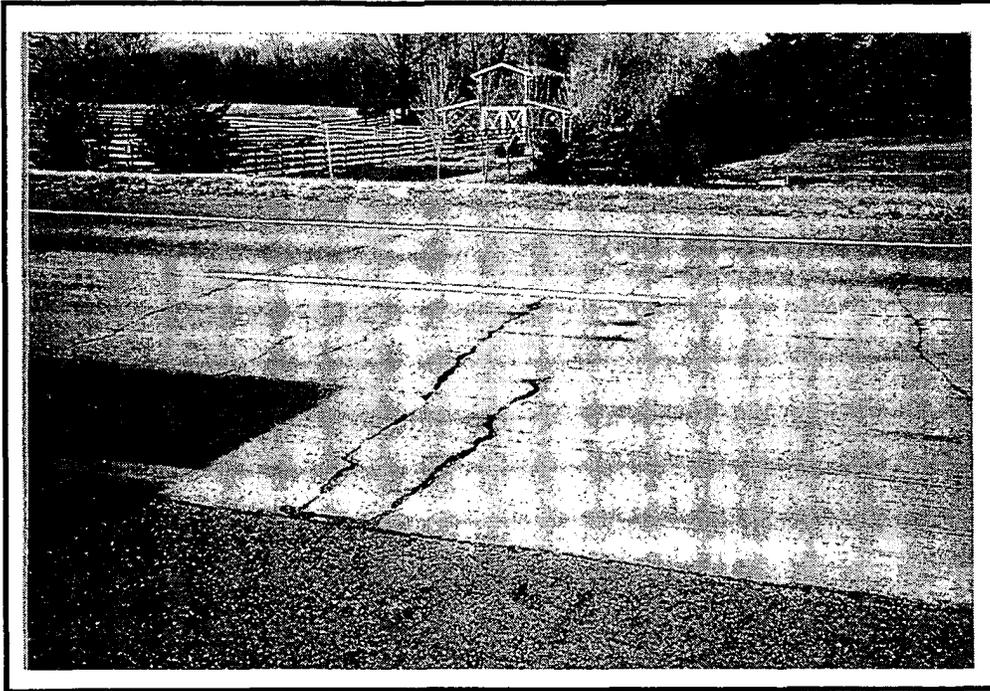


Photo D-16. Spalling in CRC Pavement, Medium Severity

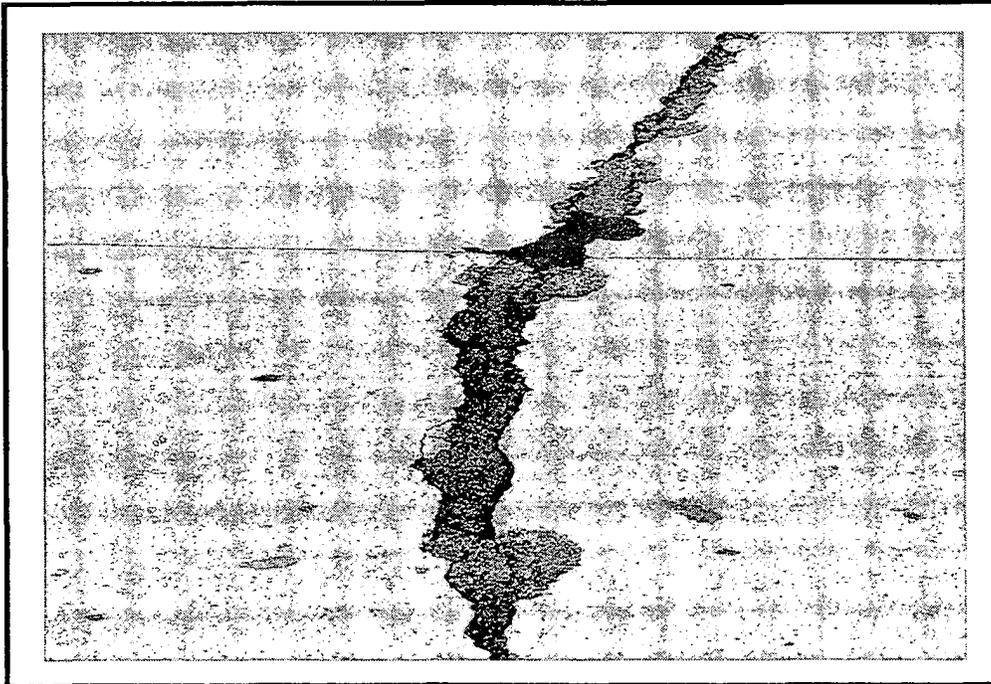


Photo D-17. Spalling in CRC Pavement, High Severity

CRC PAVEMENT

Distress Type: **Pressure Damage**

Description: Pressure damage may be spalling, crushing, or upheaval at transverse joints or cracks resulting from expansion of the concrete layer. Pressure induced spalling is differentiated from other joint spalling by the shape of the spalled area. Pressure spalls are usually 150 to 300 mm (6 to 12 inches) long measured from the crack or joint and up to 300 mm (12 inches) wide.

Severity Level: Separate severity levels for pressure damage spalling are not defined. All pressure damage spalling is considered severe since this distress may be a predictor of more serious pressure distress (blow ups).

Extent Level: Extent is based upon the number of transverse joints which exhibit pressure damage spalling.

Occasional-- Less than 1 joint/1.6 km (per mile).

Frequent-- Between 1 and 3 joints/1.6 km (per mile).

Extensive-- More than 3 joints/1.6 km (per mile).

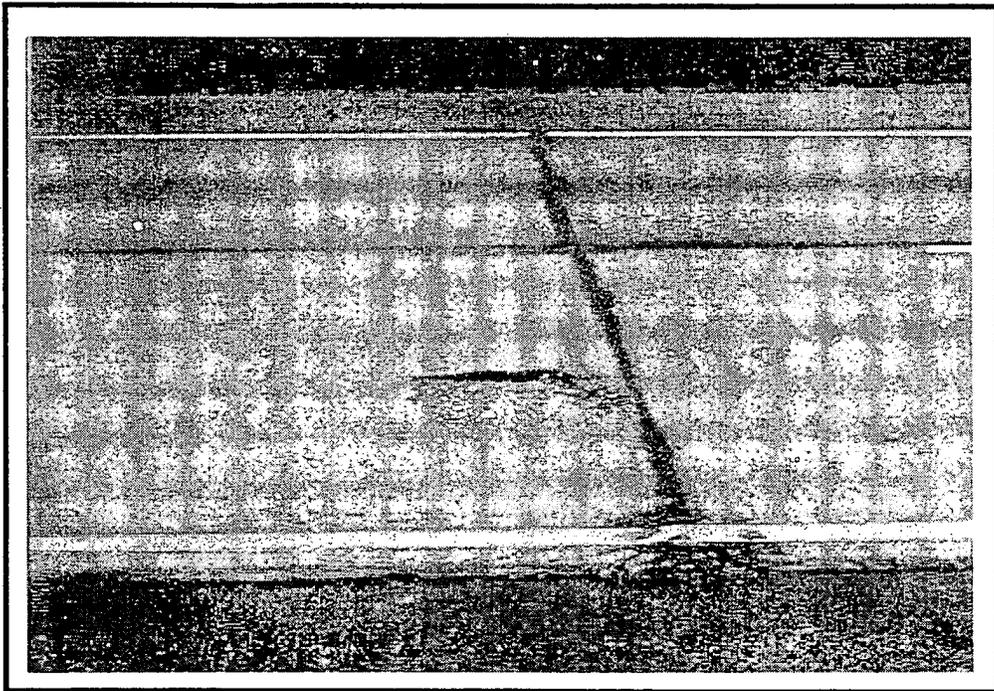
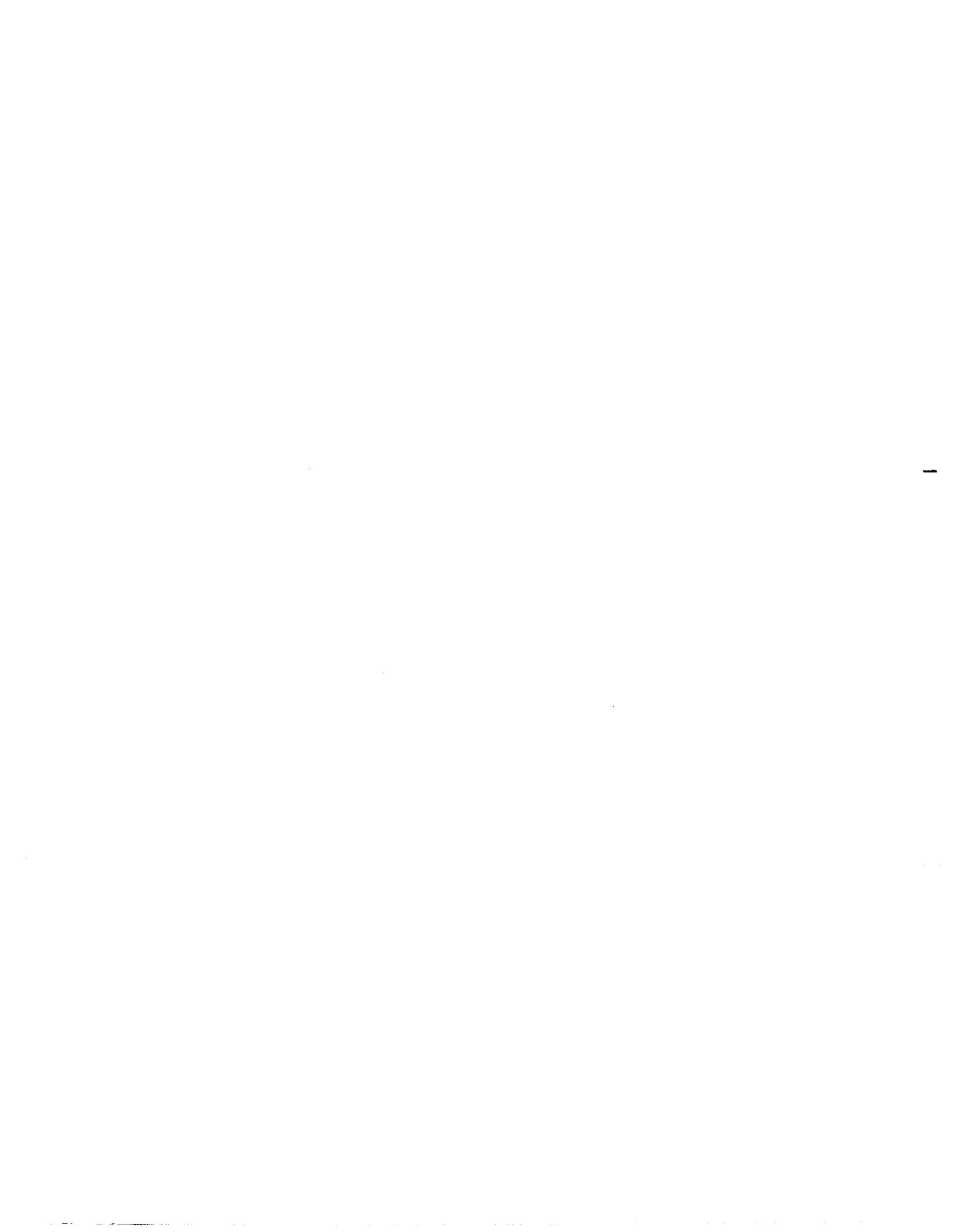


Photo D-18. An Example of Pressure Damage in Jointed Concrete Pavement. Pressure Damage in CRCP is similar to as shown above.





APPENDIX E

Sources of Photographs used in Appendices A - D

Abbreviations Used in the Tables:

RII	=	Resource International, Inc.;
ODOT	=	Ohio Department of Transportation;
SHRP	=	SHRP-P-338 "Distress Identification manual for the Long-Term Pavement Performance Project", Dated 1993;
Old Manual	=	ODOT's previous PCR Manual, Dated February 1997.

Table E-1. List of Sources of Photographs of Appendix A and B

Photo #	Source	Photo #	Source
A-1	RII	B-1	RII
A-2	ODOT	B-2	ODOT
A-3	Old Manual	B-3	Old Manual
A-4	ODOT	B-4	ODOT
A-5	Old Manual	B-5	ODOT
A-6	ODOT	B-6	ODOT
A-7	SHRP	B-7	ODOT
A-8	ODOT	B-8	ODOT
A-9	RII	B-9	ODOT
A-10	ODOT	B-10	RII
A-11	ODOT	B-11	ODOT
A-12	RII	B-12	ODOT
A-13	Old Manual	B-13	RII
A-14	RII	B-14	RII
A-15	Old Manual	B-15	ODOT
A-16	RII	B-16	ODOT
A-17	RII	B-17	RII
A-18	ODOT	B-18	ODOT
A-19	ODOT	B-19	ODOT
A-20	RII	B-20	ODOT
A-21	ODOT	B-21	RII
A-22	RII	B-22	ODOT
A-23	RII		
A-24	Old Manual		

Table E-2. List of Sources of Photographs Appendix C and D

Photo #	Source	Photo #	Source
C-1	RII	D-1	RII
C-2	RII	D-2	SHRP
C-3	RII	D-3	RII
C-4	RII	D-4	RII
C-5	ODOT	D-5	ODOT
C-6	ODOT	D-6	ODOT
C-7	ODOT	D-7	ODOT
C-8	ODOT	D-8	ODOT
C-9	RII	D-9	Old Manual
C-10	ODOT	D-10	RII
C-11	RII	D-11	RII
C-12	RII	D-12	RII
C-13	RII	D-13	RII
C-14	RII	D-14	Old Manual
C-15	RII	D-15	Old Manual
C-16	ODOT	D-16	RII
C-17	ODOT	D-17	ODOT
C-18	RII	D-18	ODOT
C-19	ODOT		
C-20	RII		
C-21	RII		
C-22	Old Manual		
C-23	ODOT		