HIGHWAY PAVEMENT DISTRESS IDENTIFICATION MANUAL

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This manual was developed by Roger E. Smith, Michael I. Darter, and Stanley M. Herrin, Department of Civil Engineering, University of Illinois, Urbana Campus, under two separate contracts sponsored by the Structures and Applied Mechanics Division, Office of Research of the Federal Highway Administration (FHWA), and by the National Cooperative Highway Research Program, administered and monitored through the Transportation Research Board as Project 1-19. This interim draft is to serve as an updated replacement manual for Technical Information Pamphlet C-48 for use in conducting the nationwide survey, "Highway Condition and Quality of Highway Construction Survey."

Although this draft has not been officially approved for publication by the sponsoring agencies, the material has been reviewed and is considered an improvement over pamphlet C-48 and is being printed and distributed by the Construction and Maintenance Division, Office of Highway Operations of the FHWA. The purpose of the distribution is to help promote the uniform evaluation of pavement conditions during the nationwide survey. Final versions for public dissemination will be issued later by the sponsoring agencies upon completion of the two respective research studies.

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16. Abstract

This manual provides standardized identification of distress types associated with four types of conventional highway pavements. These include: jointed plain concrete, jointed reinforced concrete, continuously reinforced concrete, asphalt surfaced with granular or stabilized base and asphalt overlays over portland cement concrete. Each distress type is described along with its primary mechanism, levels of severity are defined, measurement criteria provided, and typical photographs of each type and severity are provided.

17. Key Words

Distress, Pavement, Condition, Evaluation, Performance, Highway, Transportation, Asphalt, Concrete

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CHAPTER 1

INTRODUCTION

A "Highway Pavement Distress Identification Manual" has been developed for four basic types of pavements. These include (1) asphalt concrete surfaced (including asphalt overlays over concrete), (2) jointed plain concrete, (3) jointed reinforced concrete, and (4) continuously reinforced concrete. Each distress is described along with its general mechanism, levels of distress severity are defined, measurement criteria provided, and typical photographs of each type and severity.

The distress definitions were developed based initially on the airfield distress identification manual by Shahin, Darter and Kohn[1] and the "Standard Nomenclature and Definitions for Pavement Components and Deficiencies" (Special Report 113, Highway Research Board); and considerably further developed through extensive field surveys and discussions with state highway engineers. The photographs were obtained during many field trips and surveys conducted on highways located throughout the United States. This manual can be used as a standard guide for distress identification and measurement for highway pavements.

A recommended field survey procedure is as follows for highway projects having an overall length of about 1 mile (1.6 km) or more: (1) divide the project into inspection units of approximately 0.1 mile (.16 km) length; (2) randomly select a minimum of one inspection unit in each mile of the project; (3) conduct a detailed distress survey of each 0.1 mile (.16 km) inspection unit selected.

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[1] Shahin, M. Y., M. I. Darter, and S. D. Kohn, "Development of a Pavement Maintenance Management System, Vol. V, Proposed Revision of Chapter 3, AFR 93-5," Report No. CEE-DO-TR-77-44, U. S. Air Force, 1977.

ASPHALT SURFACED DISTRESS

Name of Distress: Alligator or Fatigue Cracking

Description: Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface (or stabilized base) under repeated traffic loading. The cracking initiates at the bottom of the asphalt surface (or stabilized base) where tensile stress and strain is highest under a wheel load. The cracks propagate to the surface initially as one or more longitudinal parallel cracks. After repeated traffic loading the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are usually less than 1 ft. on the longest side. Alligator cracking occurs only in areas that are subjected to repeated traffic loadings. Therefore, it would not occur over an entire area unless the entire area was subjected to traffic loading. Alligator cracking does not occur in asphalt overlays over concrete slabs. Pattern-type cracking which occurs over an entire area that is not subjected to loading is rated as block cracking which is not a load-associated distress. Alligator cracking is considered a major structural distress.

Severity Levels: L* - Longitudinal disconnected hairline cracks running parallel to each other. The cracks are not spalled. Initially there may only be a single crack in the wheel path (defined as Class 1 cracking at AASHO Road Test).

M* - Further development of low severity alligator cracking into a pattern of pieces formed by cracks that may be lightly surface spalled. Cracks may be sealed (defined as Class 2 cracking at AASHO Road Test).

H* - Medium alligator cracking has progressed so that pieces are more severely spalled at the edges and loosened until the cells rock under traffic. Pumping may exist (defined as Class 3 cracking at AASHO Road Test).

How to Measure: Alligator cracking is measured in square feet or square meters of surface area. The major difficulty in measuring this type of distress is that many times two or three levels of severity exist whthin one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately. However, if the different levels of severity cannot be easily divided, the entire area should be rated at the highest severity level present.

*L - Low severity level
*M - Medium severity level
*H - High severity level

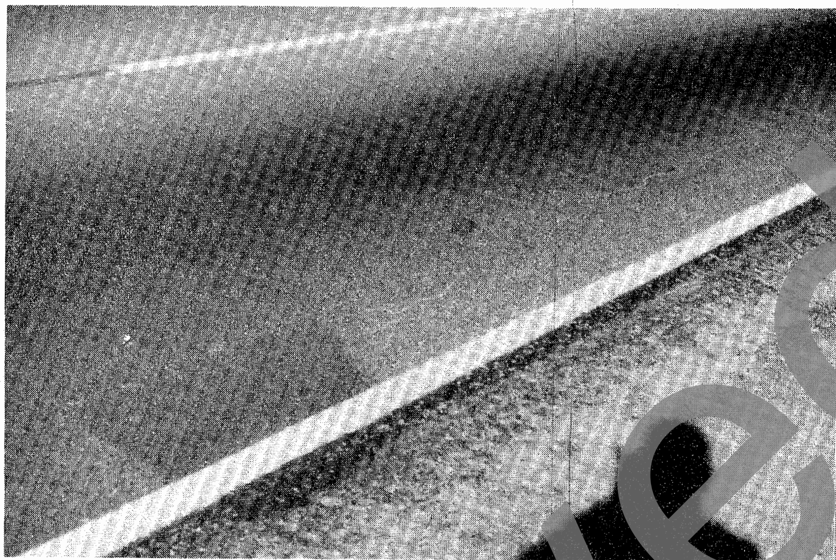

Figure 2.1. Low Severity Alligator Cracking (fine longitudinal cracks in wheel path).

Figure 2.2. Low Severity Alligator Cracking (fine longitudinal cracks in wheel path).

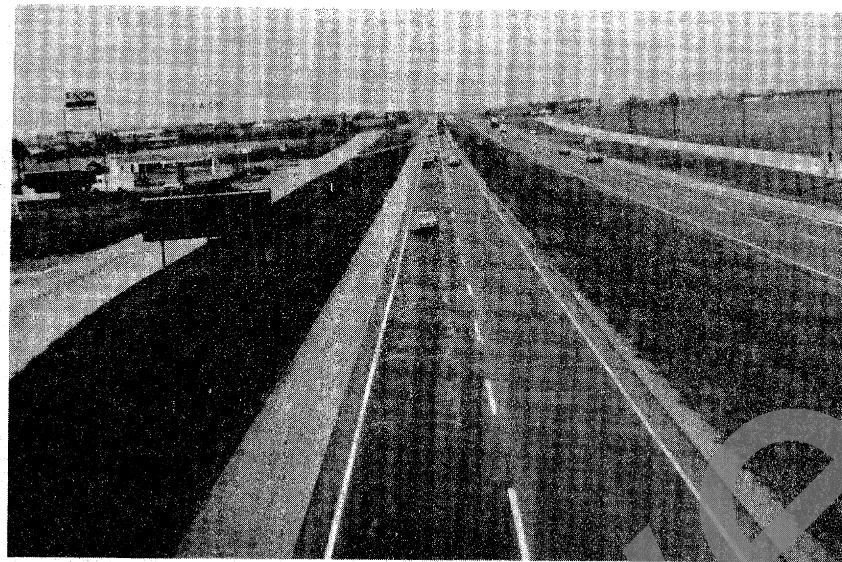

Figure 2.3. Low Severity Alligator Cracking (sealed longitudinal cracks in wheel path of outer truck lane).

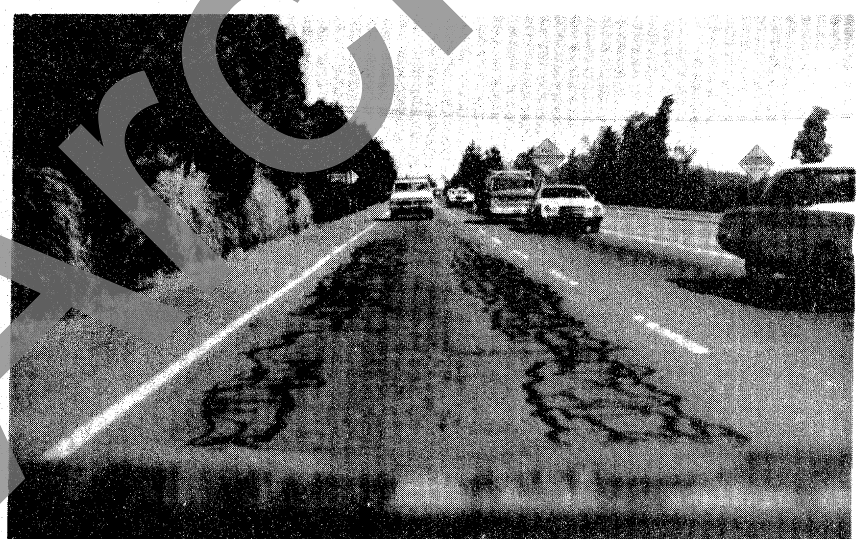

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Figure 2.5. Medium Severity Alligator Cracking in Wheel Paths.

Figure 2.6. Medium Severity Alligator Cracking in Wheel Paths Near Longitudinal Joint in Shoulder Due to Encroaching Traffic and Loss of Support.

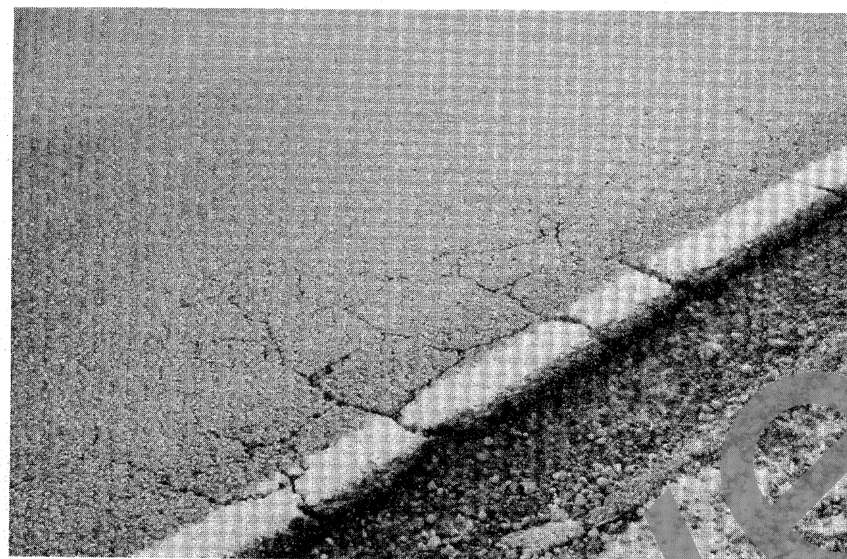

Figure 2.7. Medium Severity Alligator Cracking in Wheel Paths.

Figure 2.8. Medium Alligator Cracking at Free Edge of Lane.

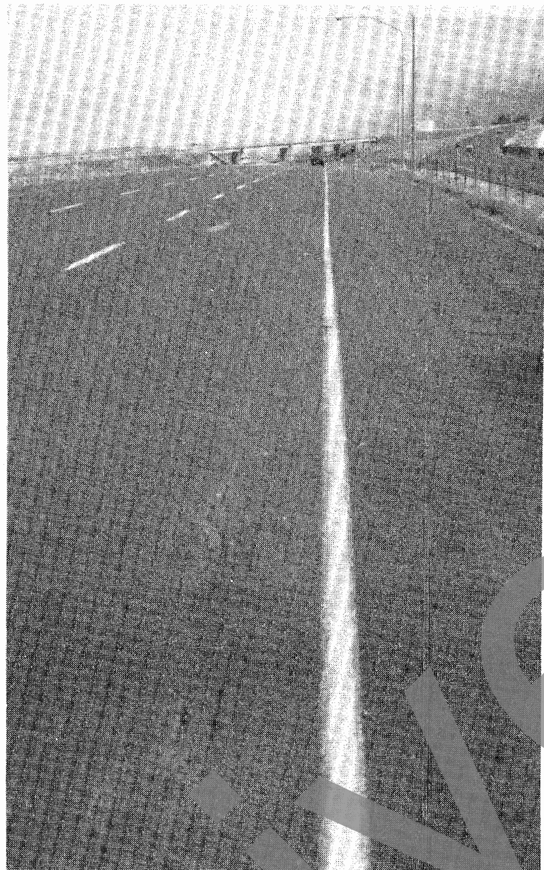

Figure 2.9. Medium Alligator Cracking in Outer Wheel Path (pumping also exists).

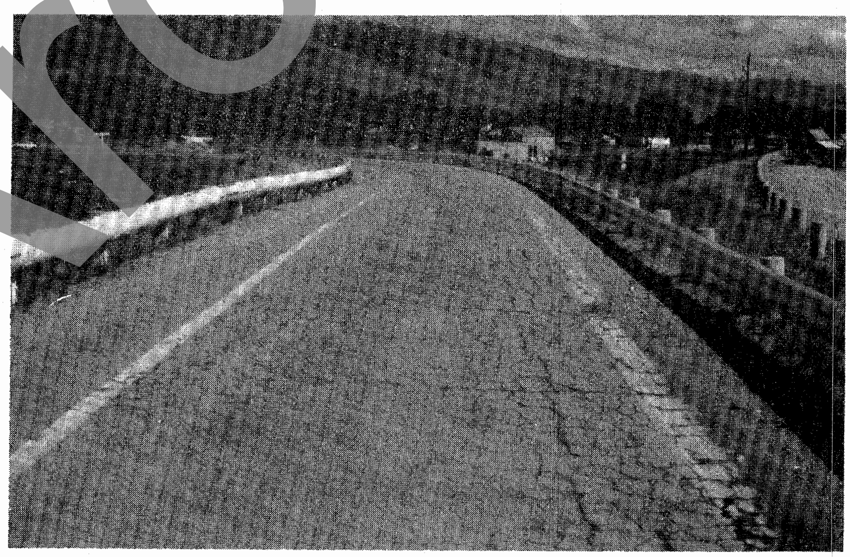

Figure 2.10. High Severity Alligator Cracking (in portions of picture where pieces are severely spalled).

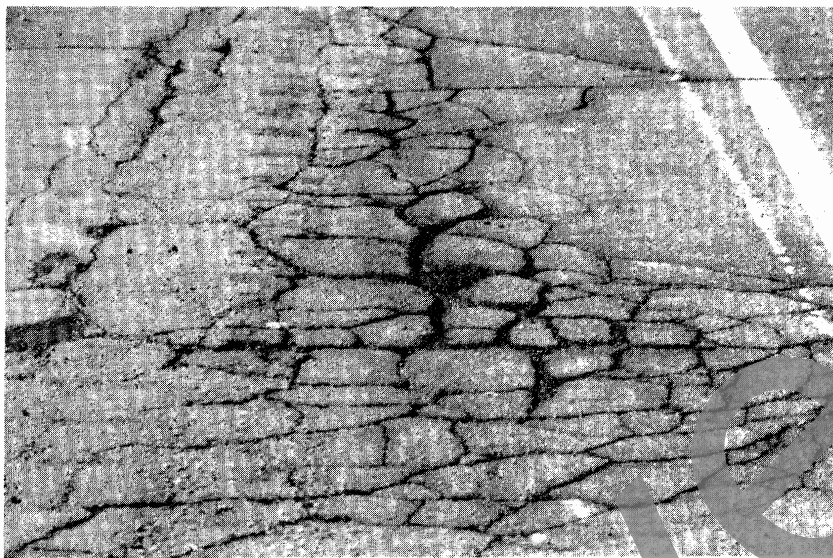

Figure 2.11. High Severity Alligator Cracking in Center of Photo Where Pieces Are Severely Spalled.

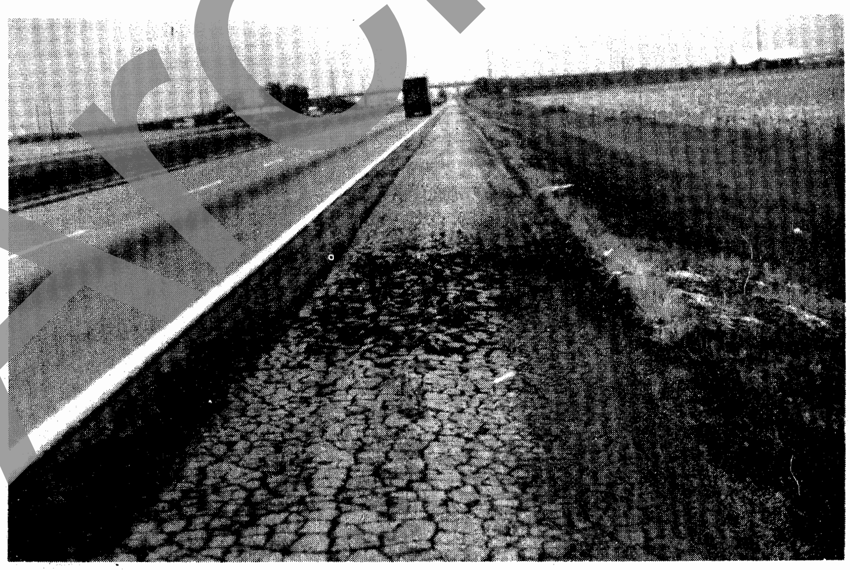

Figure 2.12. High Severity Alligator Cracking of Shoulder Where Large Amount of Trucks Park.

Name of Distress: Bleeding

Description: Bleeding is a film of bituminous material on the pavement surface which creates a shiny, glass-like, reflecting surface that usually becomes quite sticky. Bleeding is caused by excessive amounts of asphalt cement in the mix and/or low air void contents. It occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt will accumulate on the surface.

Severity Levels: No degrees of severity are defined. Bleeding should be noted when it is extensive enough to cause a reduction in skid resistance.

How to Measure: Bleeding is measured in square feet or square meters of surface area.

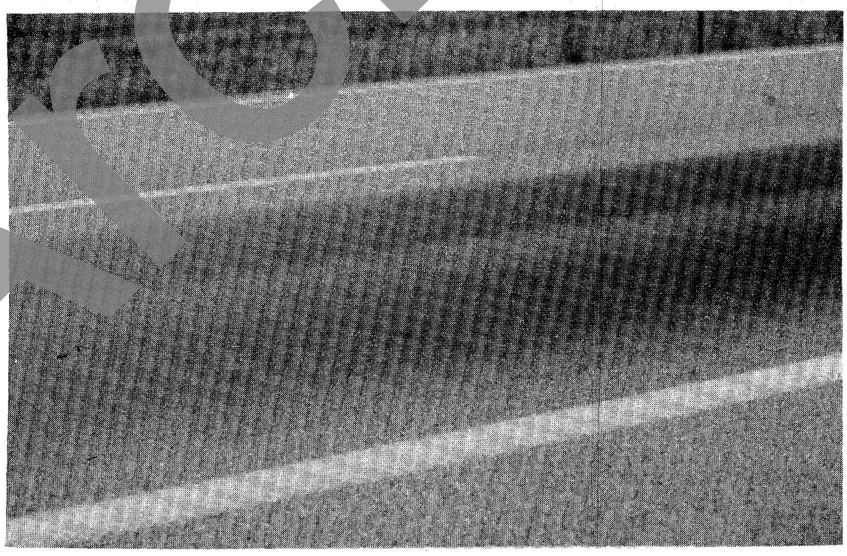

Figure 2.13. Bleeding in Wheel Paths.

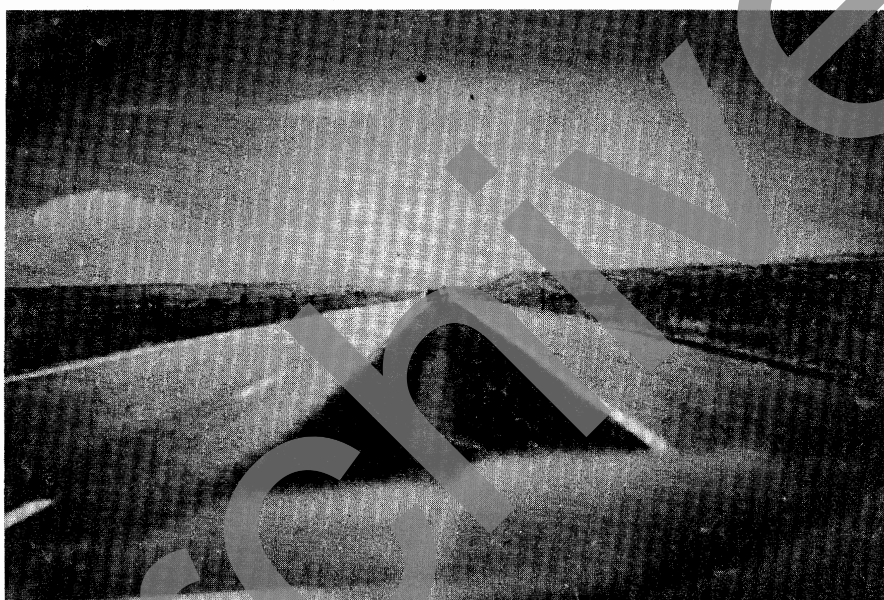

Figure 2.14. Bleeding in Wheel Paths.

Name of Distress: Block Cracking

Description: Block cracks divide the asphalt surface into approximately rectangular pieces. The blocks range in size from approximately 1 ft^2 to 100 ft^2. Cracking into larger blocks are generally rated as longitudinal and transverse cracking. Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling (which results in daily stress/strain cycling). It is not load-associated, although load can increase the severity of individual cracks from low to medium to high. The occurrence of block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large proportion of pavement area, but sometimes will occur only in nontraffic areas. This type of distress differs from alligator cracking in that alligator cracks form smaller, many-sided pieces with sharp angles. Also unlike block cracks, alligator cracks are caused by repeated traffic loadings, and are, therefore, located only in trafficked areas (i.e., wheel paths).

Severity Levels:

L - Blocks are defined by (1) nonsealed cracks that are nonspalled (sides of the crack are vertical) or only minor spalling with a 1/4 in. (6 mm) or less mean width; or (2) sealed cracks have a sealant in satisfactory condition to prevent moisture infiltration.

M - Blocks are defined by either (1) sealed or nonsealed cracks that are moderately spalled; (2) nonsealed cracks that are not spalled or have only minor spalling, but have a mean width greater than approximately 1/4 in. (6 mm) or (3) sealed cracks that are not spalled or have only minor spalling, but have sealant in unsatisfactory condition.

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

How to Measure: Block cracking is measured in square feet or square meters of surface area. It usually occurs at one severity level in a given pavement section; however, any areas of the pavement section having distinctly different levels of severity should be measured and recorded separately.

Figure 2.15. Low Severity Block Cracking.

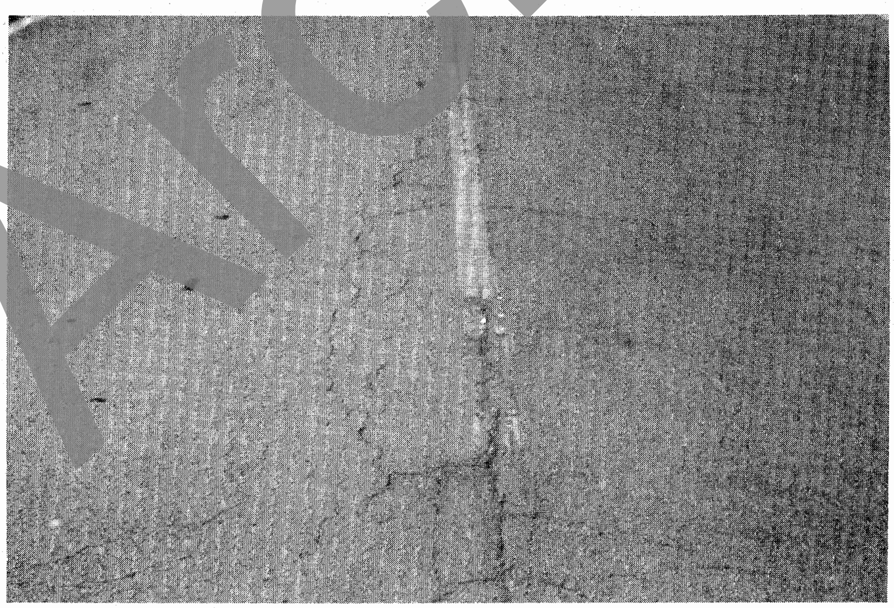

Figure 2.16. Low Severity Block Cracking Near Centerline.

Figure 2.17. Medium Severity Block Cracking.

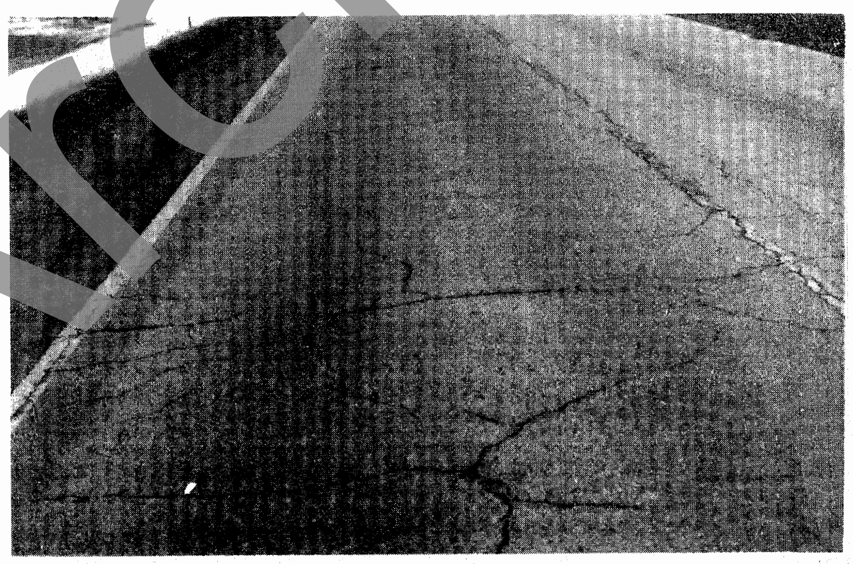

Figure 2.18. Medium Severity Block Cracking.

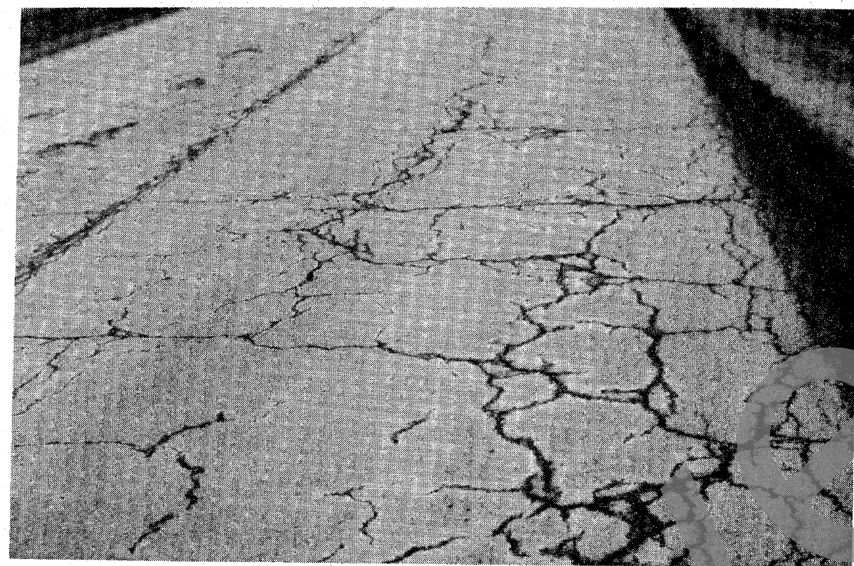

Figure 2.19. High Severity Block Cracking.

Figure 2.20. High Severity Block Cracking.

Name of Distress: Corrugation

Description: Corrugation is a form of plastic movement typified by ripples across the asphalt pavement surface. It occurs usually at points where traffic starts and stops. Corrugation usually occurs in asphalt layers that lack stability in warm weather, but may also be attributed to excessive moisture in a subgrade, contamination of the mix, or lack of aeration of liquid asphalt mixes.

Severity Levels:

L - Corrugations cause some vibration of the vehicle which creates no discomfort.

M - Corrugations cause significant vibration of the vehicle which creates some discomfort.

H - Corrugations cause excessive vibration of the vehicle which creates substantial discomfort, and/or a safety hazard, and or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Corrugation is measured in square feet or square meters of surface area. Severity levels are determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

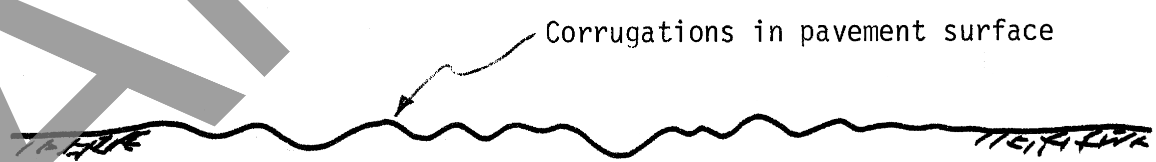

Figure 2.21. Illustrative Diagram of Corrugation Profile.

Name of Distress: Depression

Description: Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. In many instances, light depressions are not noticeable until after a rain, when ponding water creates "birdbath" areas; but the depressions can also be located without rain because of strains created by oil droppings from vehicles. Depressions can be caused by settlement of the foundation soil or can be "built in" during construction. Depressions cause roughness, and when filled with water of sufficient depth could cause hydroplaning of vehicles.

Severity Levels:

L - Depressions cause some bounce of the vehicle which creates no discomfort.

M - Depressions cause significant bounce of the vehicle which creates some discomfort.

H - Depressions cause excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Depressions are measured in square feet or meters in each inspection unit. Each depression is rated according to its level of severity. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Figure 2.22. Low Severity Depression (identified by oil droppings on pavement surface).

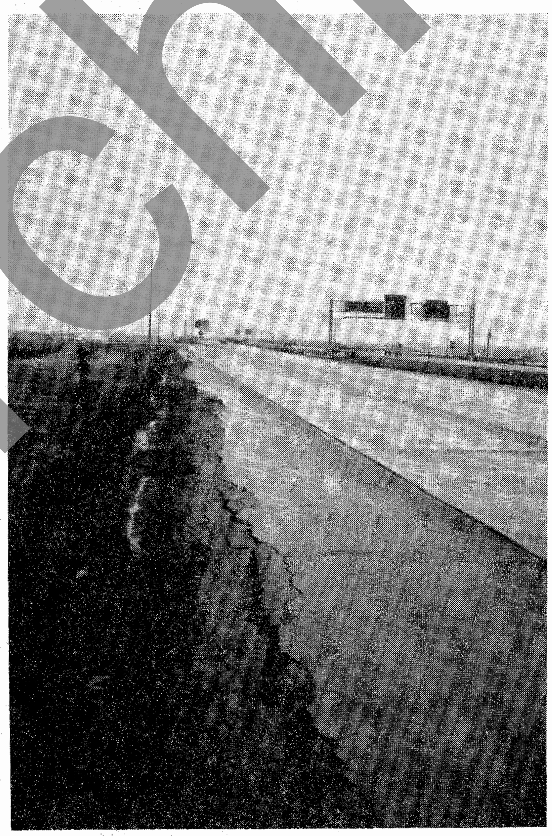

Figure 2.23. High Severity Depression in Shoulder (high severity alligator cracking also exists and would be recorded in addition to the depression).

Name of Distress: Joint Reflection Cracking from PCC Slab

Description: This distress occurs only on pavements having an asphalt concrete surface over a jointed portland cement concrete (PCC) slab and they occur at transverse and longitudinal joints (i.e., widening joints). This distress does not include reflection cracking away from a joint or from any other type of base (i.e., cement stabilized, lime stabilized) as these cracks are identified as "Longitudinal and Transverse Cracking." Joint reflection cracking is caused mainly by movement of the PCC slab beneath the asphalt concrete (AC) surface because of thermal and moisture changes; it is generally not load initiated. However, traffic loading may cause a breakdown of the AC near the initial crack, resulting in spalling. A knowledge of slab dimensions beneath the AC surface will help to identify these cracks.

Severity Levels:

L - Cracks have either minor spalling or no spalling and can be sealed or nonsealed. If nonsealed, the cracks have a mean width of 1/4 in. (6 mm) or less; sealed cracks are of any width, but their sealant material is in satisfactory condition to substantially prevent water infiltration. No significant bump occurs when a vehicle crosses the crack.

M - One of the following conditions exists: (1) cracks are moderately spalled and can be either sealed or nonsealed of any width; (2) sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate; (3) nonsealed cracks are not spalled or are only lightly spalled, but the mean crack width is greater than 1/4 in. (6 mm); (4) low severity random cracking exists near the crack or at the corners of intersecting cracks; or (5) the crack causes a significant bump to a vehicle.

H - (1) Cracks are severely spalled and/or there exists medium or high random cracking near the crack or at the corners of intersecting cracks, or (2) the crack causes a severe bump to a vehicle.

How to Measure: Joint reflection cracking is measured in lineal feet or meters. The length and severity level of each crack should be identified and recorded. If the crack does not have the same severity level along its entire length, each general portion should be recorded separately. The vehicle used to determine bump severity is a mid to full sized sedan weighing approximately 3000-3800 lbs (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Figure 2.24. Low Severity Joint Reflection Cracking from Transverse Joint in PCC Slab.

Figure 2.25. Low Severity Joint Reflection Cracking from Transverse Joint in PCC Slab.

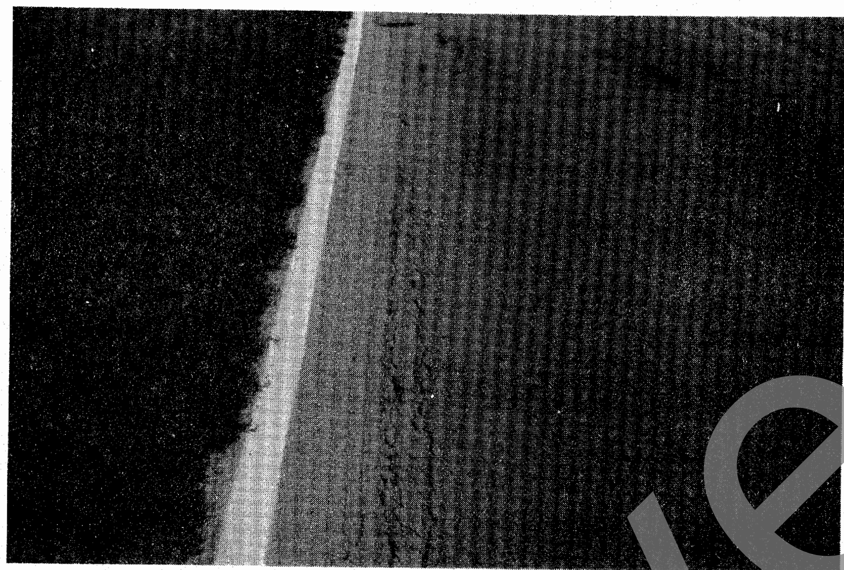

Figure 2.26. Medium Severity Joint Reflection Cracking from Longitudinal Widening Joint in PCC Slab.

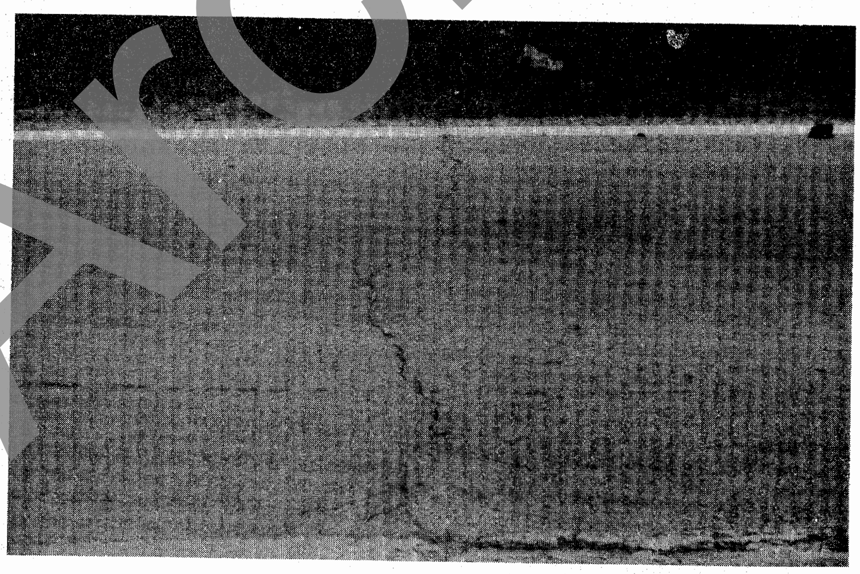

Figure 2.27. Medium Severity Joint Reflection Cracking from Transverse Joint in PCC Slab.

Figure 2.28. High Severity Joint Reflection Cracking from Transverse Joint in PCC Slab.

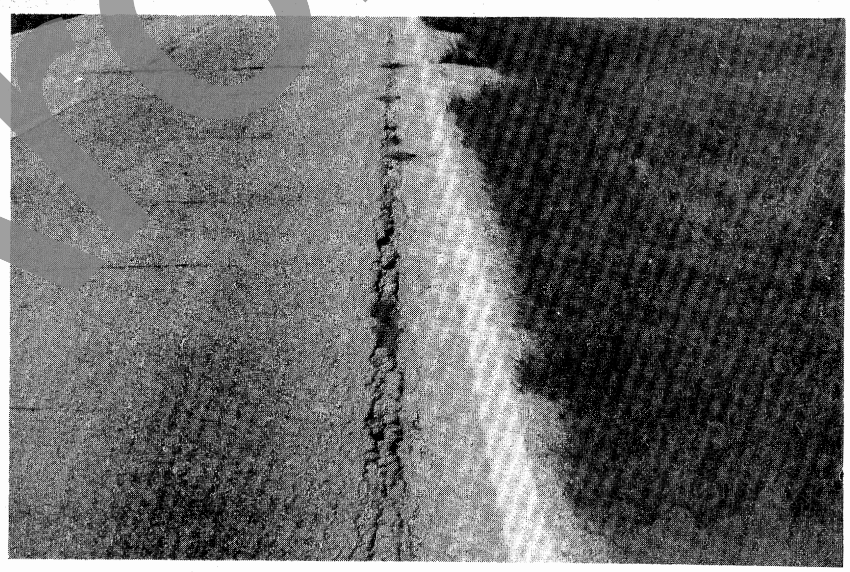

Figure 2.29. High Severity Joint Reflection Cracking from Longitudinal Widening Joint in PCC Slab.

Figure 2.30. High Severity Joint Reflection Cracking from Transverse Joint in PCC Slab.

Name of Distress: Lane/Shoulder Dropoff or Heave

Description: Lane/Shoulder dropoff or heave occurs wherever there is a difference in elevation between the traffic lane and shoulder. Typically the outside shoulder settles due to consolidation or a settlement of the underlying granular or subgrade material, or pumping of the underlying material. Heave of the shoulder may occur due to frost action or swelling soils. Dropoff of granular or soil shoulder is generally caused from blowing away of shoulder material from passing trucks.

Severity Level: Severity level is determined by computing the mean difference in elevation between the traffic lane and shoulder:

L	1/4 - 1/2 in.	(6 - 13 mm)
M	1/2 - 1 in.	(3 - 25 mm)
H	> 1 in.	(> 25 mm)

How to Measure: Lane/shoulder dropoff or heave is measured every 100 ft. (30 m) in inches (or mm) along the joint. The mean difference in elevation is computed from the data and used to determine severity level.

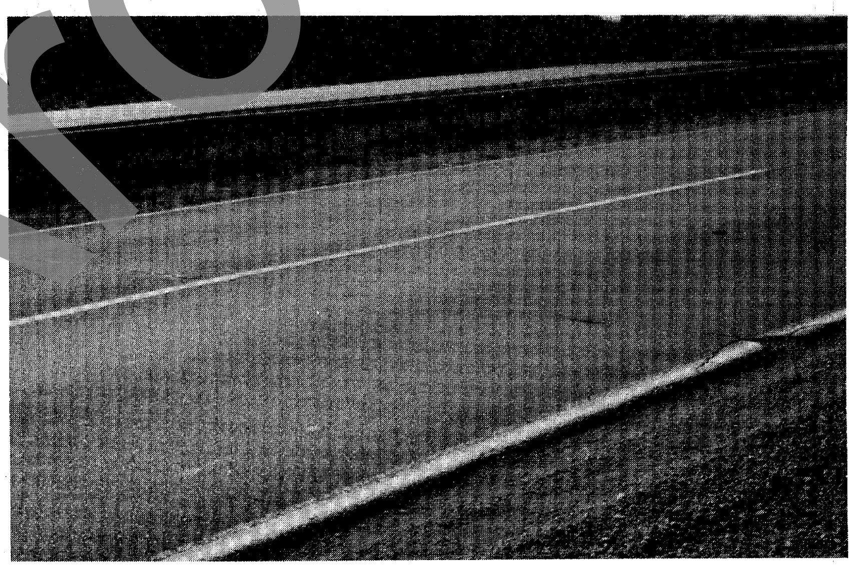

Figure 2.31. Medium Severity Lane/Shoulder Dropoff.

Name of Distress: Lane/Shoulder Joint Separation

Description: Lane/Shoulder joint separation is the widening of the joint between the traffic lane and the shoulder generally due to movement in the shoulder. If the joint is tightly closed or well sealed so water cannot enter (or if there is no joint due to full width paving), then lane/shoulder joint separation is not considered a distress. If the shoulder is not paved (i.e., gravel or grass) then the severity should be rated as high. If a curbing exists, then it should be rated according to the width of the joint between the asphalt surface and curb.

Severity Level: Severity level is determined by the mean joint opening. No severity level is counted if the joint is well sealed to prevent moisture intrusion.

L	0.04 - .12 in.	(1 - 3 mm)
M	> .12 - .40 in.	(> 3 - 10 mm)
H	> .40 in	(> 10 mm) (also a nonpaved shoulder)

How to Measure: Lane/Shoulder joint separation is measured in inches (or millimeters) at about 50 ft. (15.2 m) intervals along the sample unit. The mean separation is used to determine severity level.

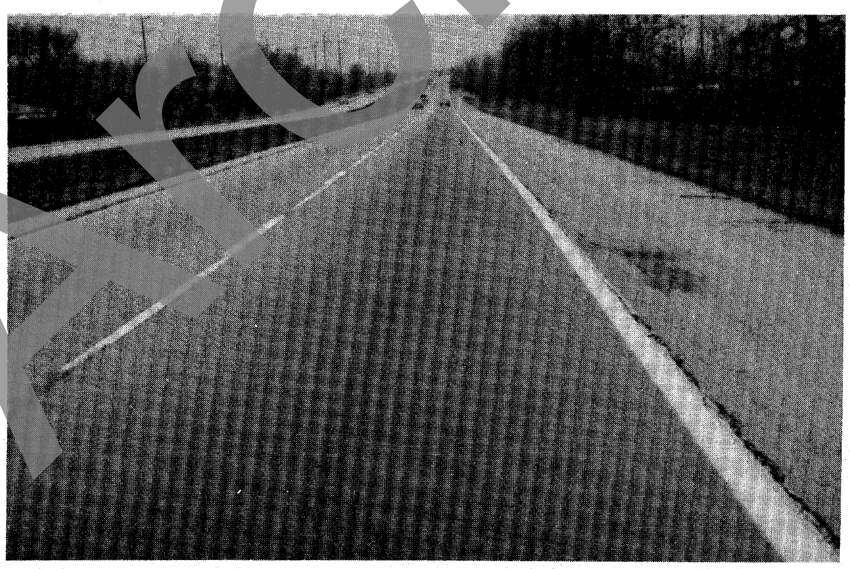

Figure 2.32. Medium Severity Lane/Shoulder Joint Separation (note separation near outside of edge paint strip). (See Figure 2.31 for photo of high severity lane/shoulder joint separation.)

Name of Distress: Longitudinal and Transverse Cracking (Non-PCC Slab Joint Reflective)

Description: Longitudinal cracks are parallel to the pavement's centerline or laydown direction. They may be caused by (1) a poorly constructed paving lane joint, (2) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or (3) a reflective crack caused by cracks beneath the surface course, including cracks in PCC slabs (but not at PCC slab joints). Transverse cracks extend across the pavement centerline or direction of laydown. They may be caused by items 2 or 3 above. These types of cracks are not usually load associated.

Severity Levels:

L - Cracks have either minor spalling or no spalling, and cracks can be sealed or nonsealed. If sealed, cracks have a mean width of 1/4 in. (6 mm) or less; sealed cracks are of any width, but their sealant material is in satisfactory condition to substantially prevent water infiltration. No significant bump occurs when a vehicle crosses the crack.

M - One of the following conditions exists: (1) cracks are moderately spalled and can either be sealed or nonsealed of any width; (2) sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate; (3) nonsealed cracks are not spalled or have only minor spalling, but mean crack width is greater than 1/4 in. (6 mm); (4) low severity random cracking exists near the crack or at the corners of intersecting cracks; or (5) the crack causes a significant bump to a vehicle.

H - (1) Cracks are severely spalled; and/or medium or high random cracking exists near the crack or at the corners of intersecting cracks, or (2) the crack causes a severe bump to a vehicle.

How to Measure: Longitudinal and transverse cracks are measured in lineal feet or lineal meters. The length and severity of each crack should be identified and recorded. If the crack does not have the same severity level along its entire length, each general portion of the crack having a different severity level should be recorded separately. The vehicle used to determine bump severity is a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Figure 2.33. Low Severity Transverse Cracking.

Figure 2.34. Low Severity Longitudinal and Transverse Cracking.

Figure 2.35. Low Severity Transverse Cracking Across Shoulder.

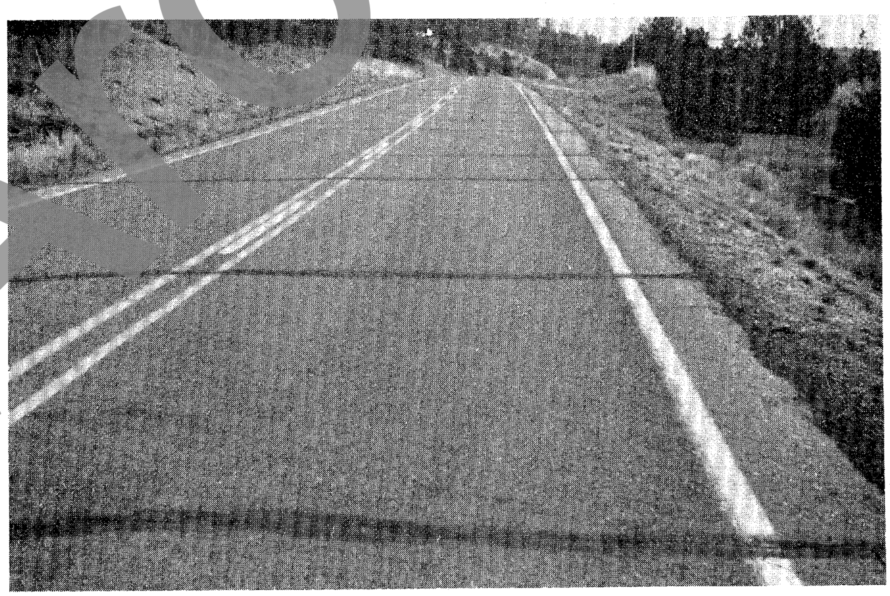

Figure 2.36. Medium Severity Transverse Cracking.

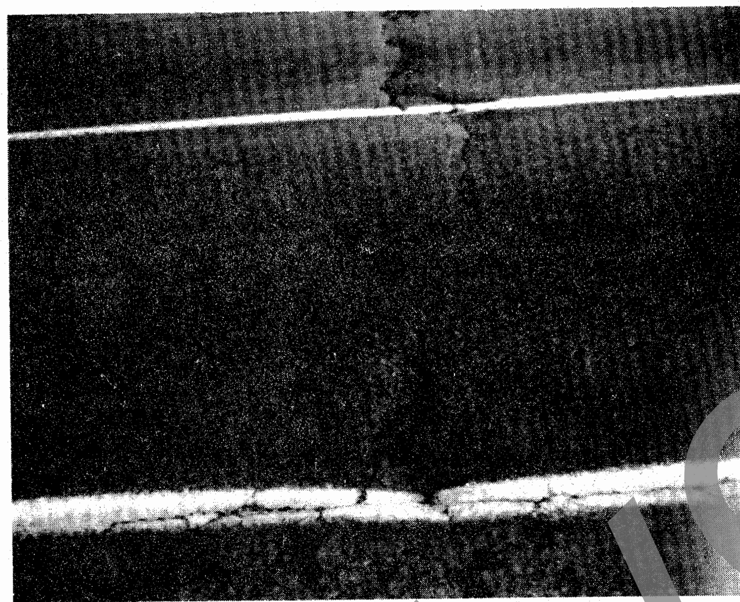

Figure 2.37. Medium Severity Transverse Cracking.

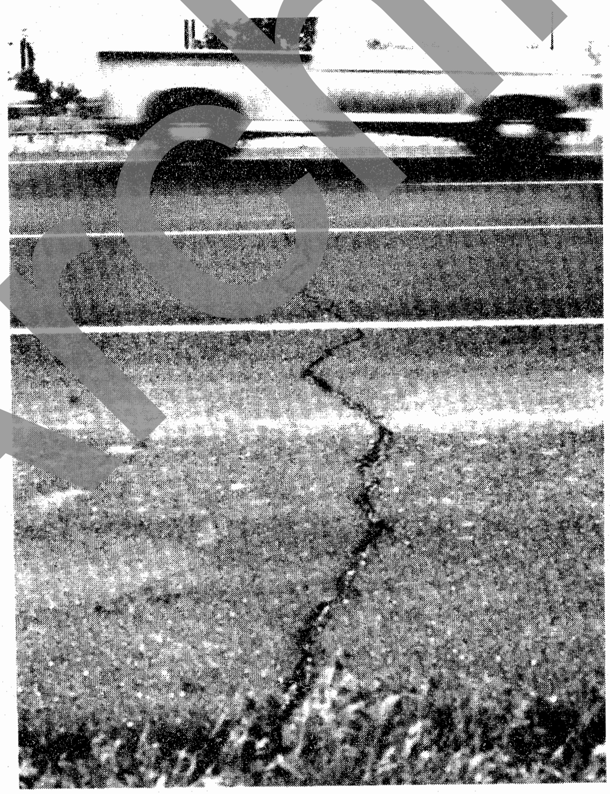

Figure 2.38. Medium Severity Transverse Cracking.

Figure 2.39. Medium Severity Transverse Cracking.

Figure 2.40. Medium Severity Transverse Cracking Across Shoulder.

Figure 2.41. High Severity Transverse Cracking.

Figure 2.42. High Severity Longitudinal Cracking.

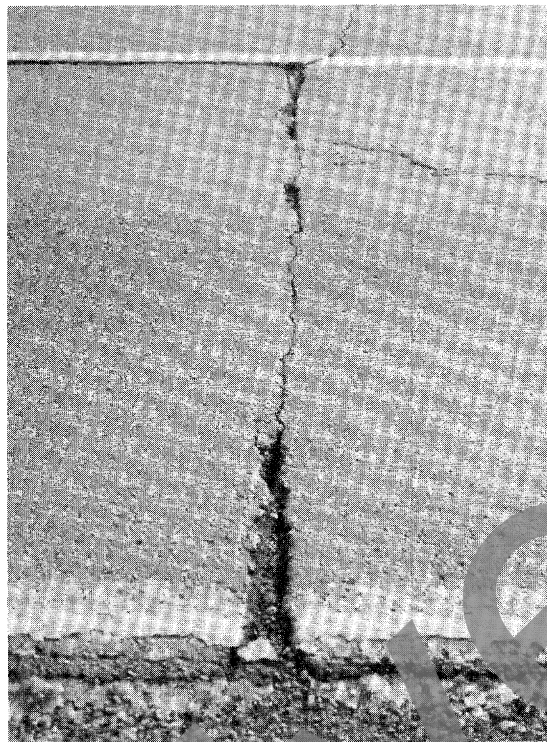

Figure 2.43. High Severity Transverse Cracking.

Figure 2.44. High Severity Transverse Cracking (this crack is caused initially by reflection from cement stabilized base).

Name of Distress: Patch Deterioration

Description: A patch is an area where the original pavement has been removed and replaced with either similar or different material.

Severity Levels:

L - Patch is in very good condition and is performing satisfactorily.

M - Patch is somewhat deteriorated, having low to medium levels of any types of distress.

H - Patch is badly deteriorated and soon needs replacement.

How to Measure: Each patch is measured in square feet or square meters of surface area. Even if a patch is in excellent condition it is still rated low severity.

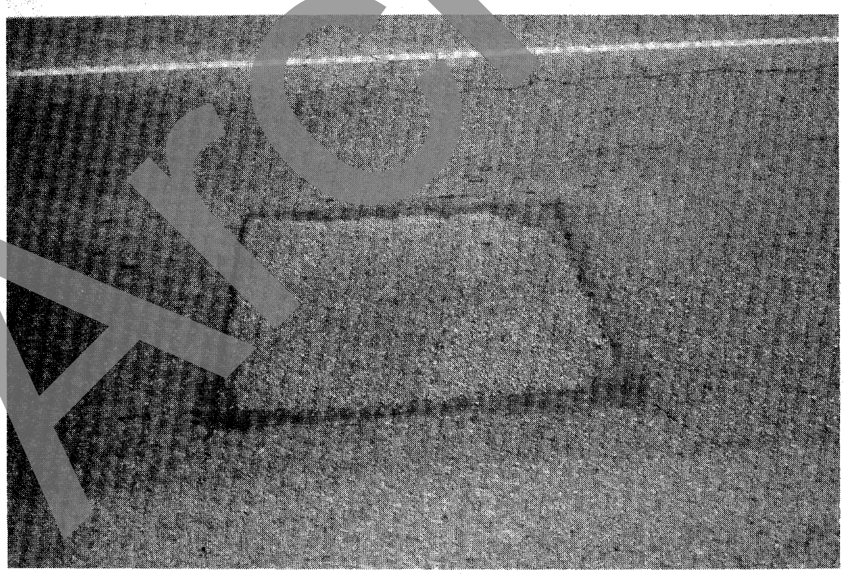

Figure 2.45. Low Severity Patch.

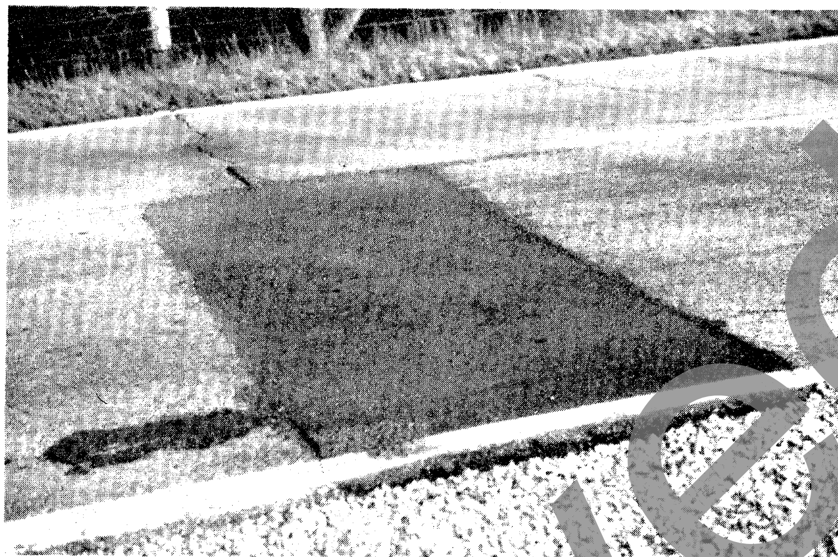

Figure 2.46. Low Severity Patch.

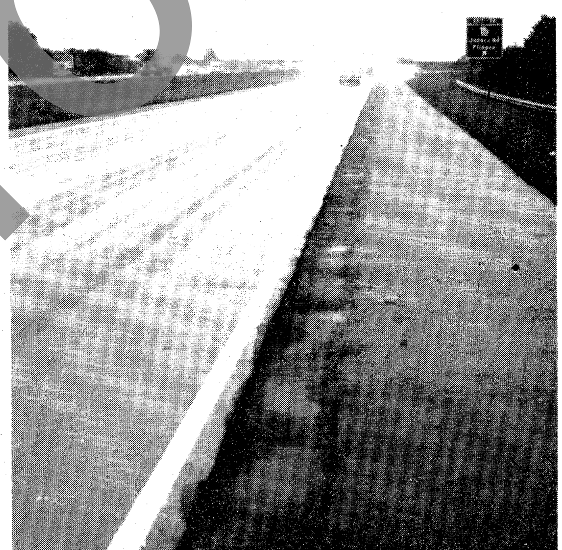

Figure 2.47. Low Severity Patch Along Shoulder Joint.

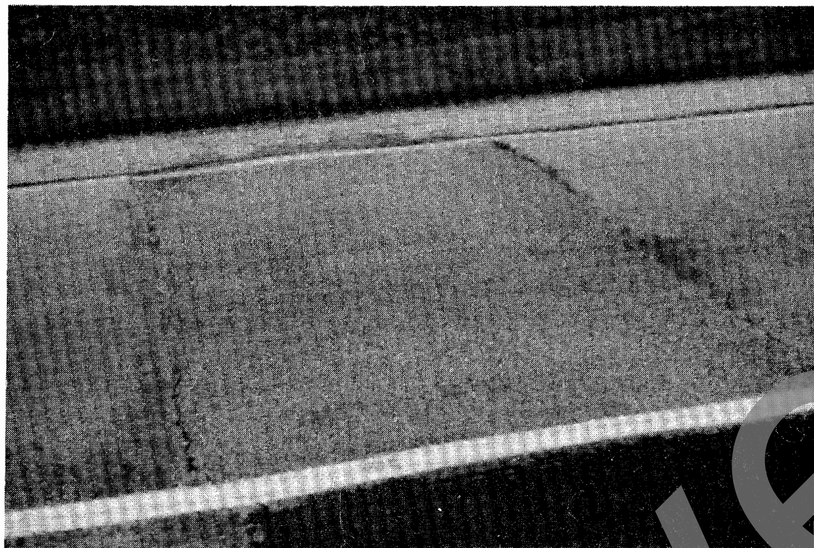

Figure 2.48. Medium Severity Patch.

Figure 2.49. Medium Severity Patch (see also Figure 2.76 for medium severity patch).

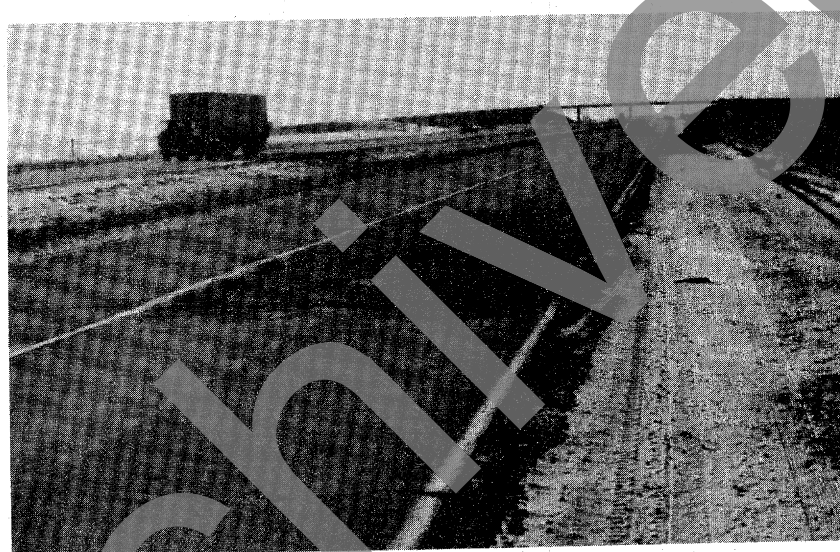

Figure 2.50. High Severity Patch.

Name of Distress: Polished Aggregate

Description: Aggregate polishing is caused by repeated traffic applications. Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small, or there are no rough or angular aggregate particles to provide good skid resistance.

Severity Levels: No degrees of severity are defined. However, the degree of polishing should be significant in reducing skid resistance before it is included as a distress.

How to Measure: Polished aggregate is measured in square ft. or square meters of surface area. The existance of polishing can be detected by both visually observing and running the fingers over the surface.

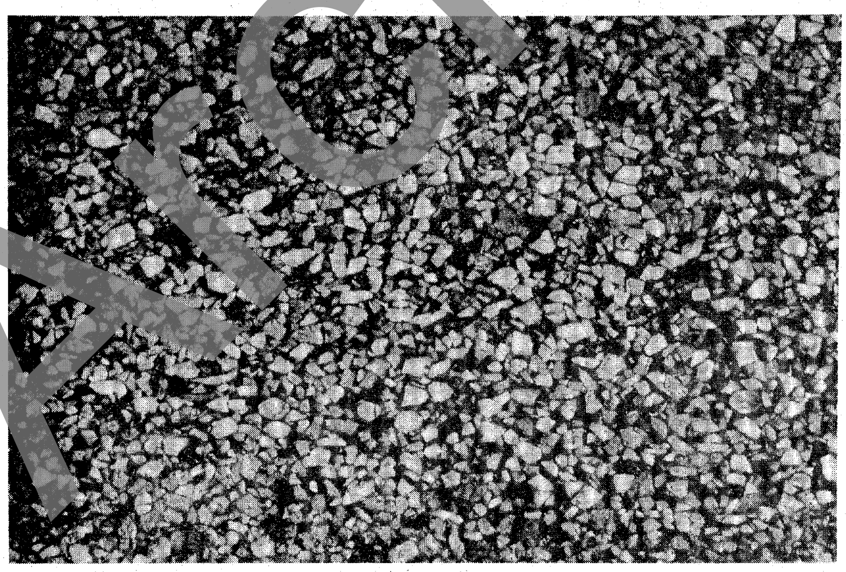

Figure 2.51. Polished Aggregate (photo taken in wheel path of 23 year old high traffic volume turnpike).

Name of Distress: Potholes

Description: A bowl shaped hole of various sizes in the pavement surface. The surface has broken into small pieces by alligator cracking or by localized disintegration of the mixture and the material is removed by traffic. Traffic loads force the underlying materials out of the hole, increasing the depth.

Severity Levels:

Area	(ft^2)	< 1	1 - 3	> 3
Depth - ins.(mm)	(m^2)	< 1/3	1/3- 1	> 1
< 1 (< 25)		L	L	M
1-2 (25-50)		M	M	H
> 2 (> 51)		M	H	H

How to Measure: Potholes are counted in numbers of holes of each severity level in the inspection unit.

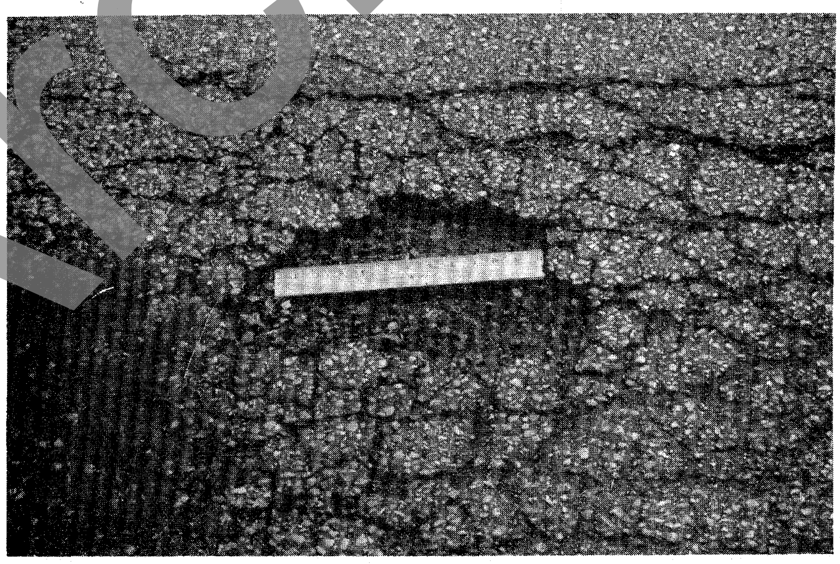

Figure 2.52. Low Severity Pothole.

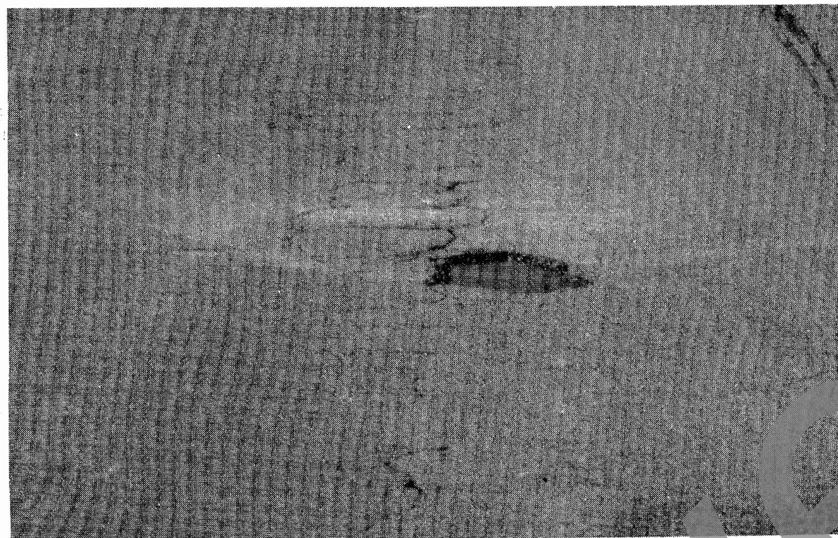

Figure 2.53. Low Severity Pothole.

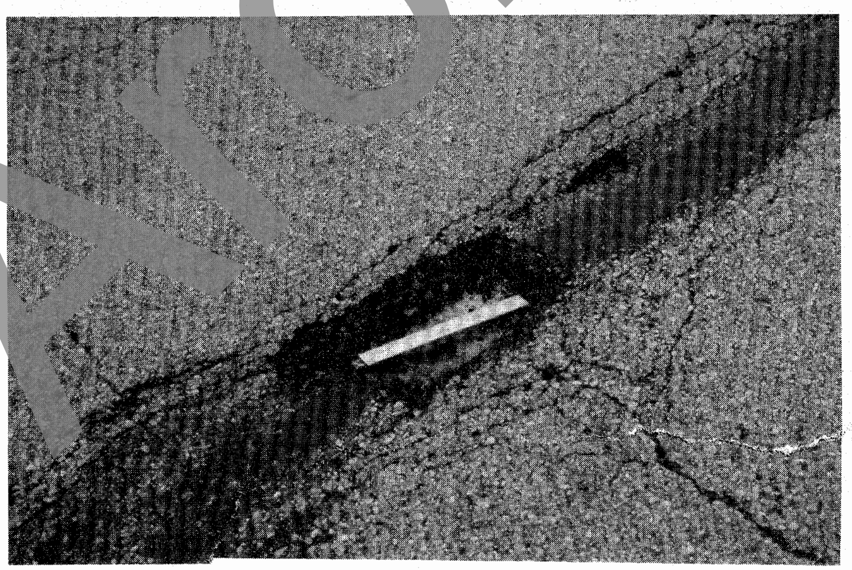

Figure 2.54. Medium Severity Pothole.

Figure 2.55. Medium Severity Pothole.

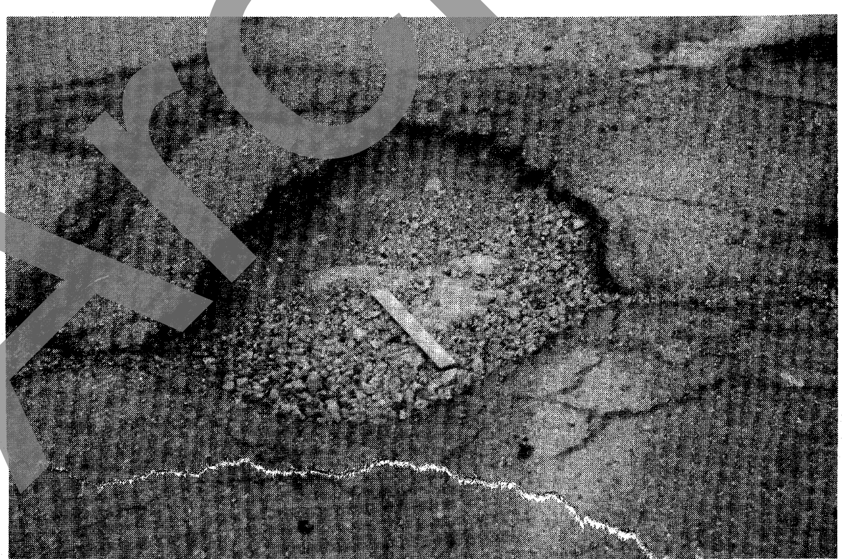

Figure 2.56. High Severity Pothole.

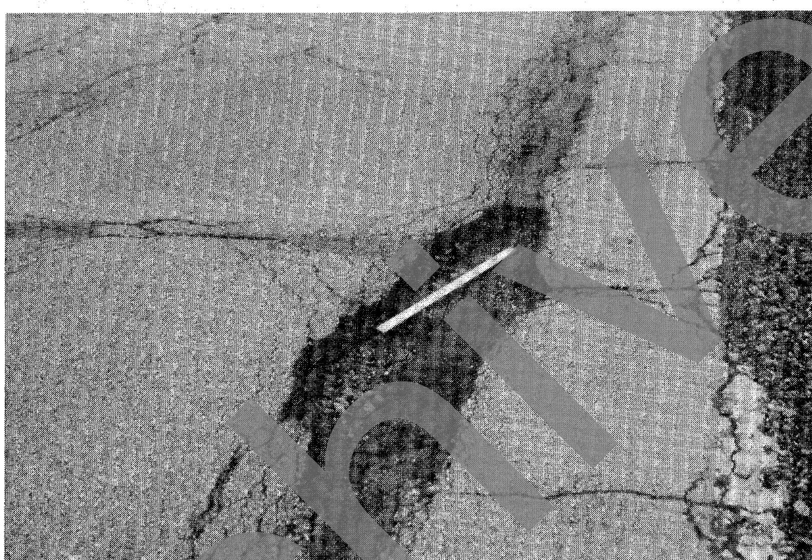

Figure 2.57. High Severity Pothole.

Name of Distress: Pumping and Water Bleeding

Description: Pumping is the ejection of water and fine materials under pressure through cracks under moving loads. As the water is ejected it carries fine material resulting in progressive material deterioration and loss of support. Several cases of pumping of stabilized base materials have been observed for example. Surface staining or accumulation of material on the surface close to cracks is evidence of pumping. Water bleeding occurs where water seeps slowly out of cracks in the pavement surface.

Severity Levels:

L - Water bleeding exists or water pumping can be observed when heavy loads pass over the pavement, however no fines (or only a very small amount) can be seen on the surface of the pavement.

M - Some pumped material can be observed near cracks in the pavement surface.

H - A significant amount of pumped material exists on the pavement surface near the cracks.

How to Count: If pumping or water bleeding exists anywhere in the sample unit it is counted as occurring.

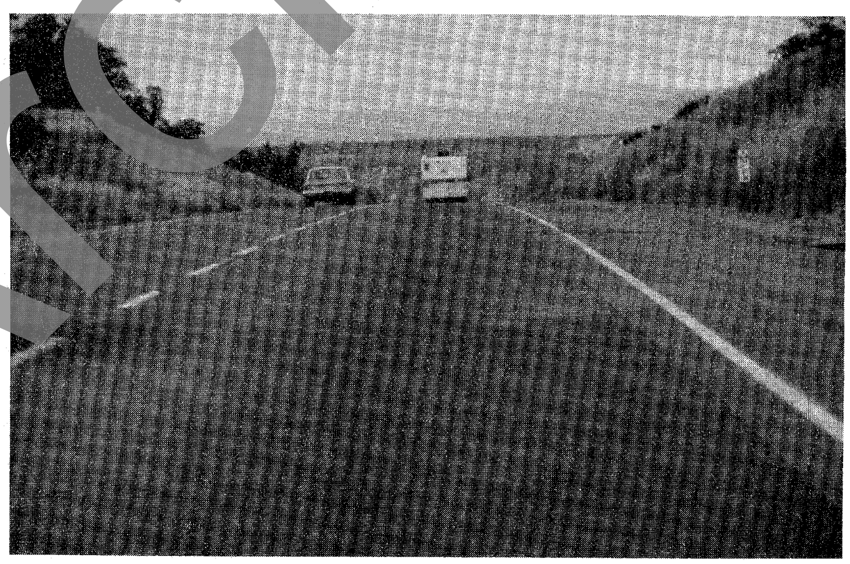

Figure 2.58. Medium Severity Pumping (stabilized base is pumping)(Note:- see also Figure 2.9 for medium severity pumping photo).

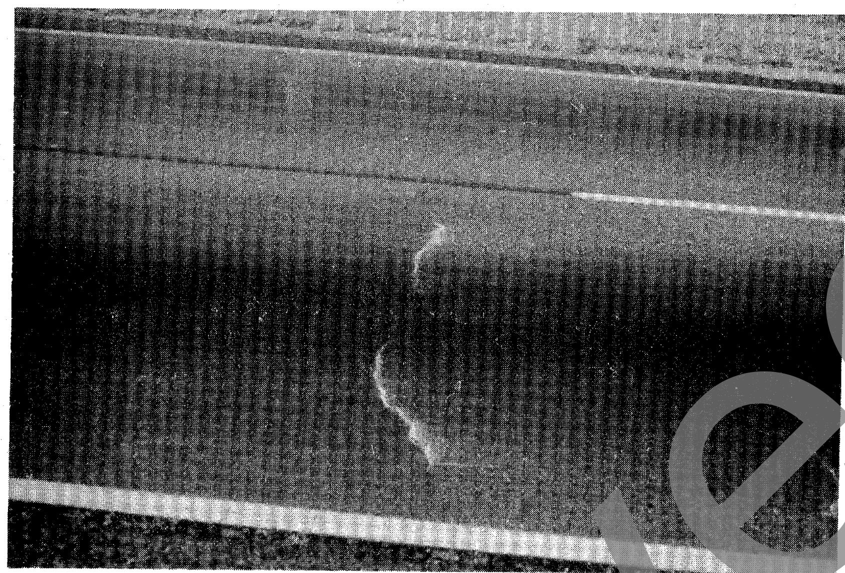

Figure 2.59. Medium Severity Pumping (stabilized base is pumping).

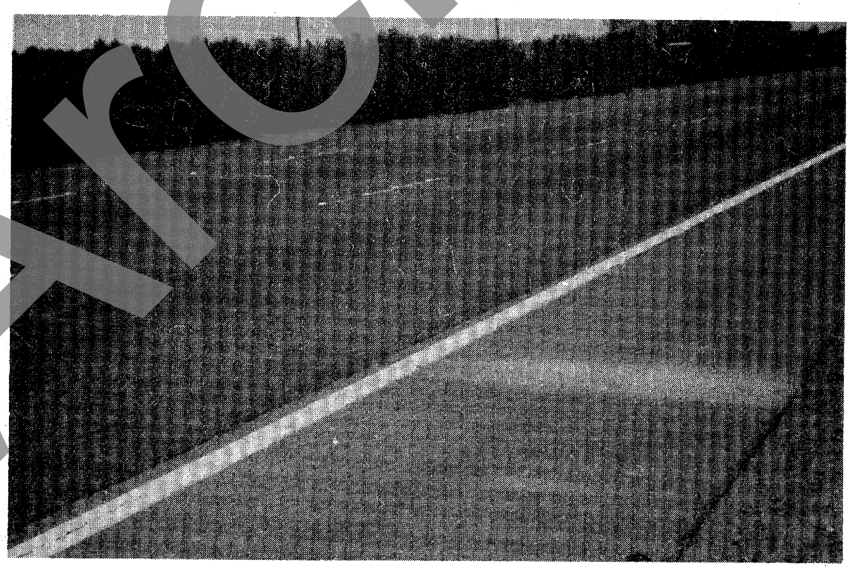

Figure 2.60. Medium Severity Pumping (stabilized base is pumping).

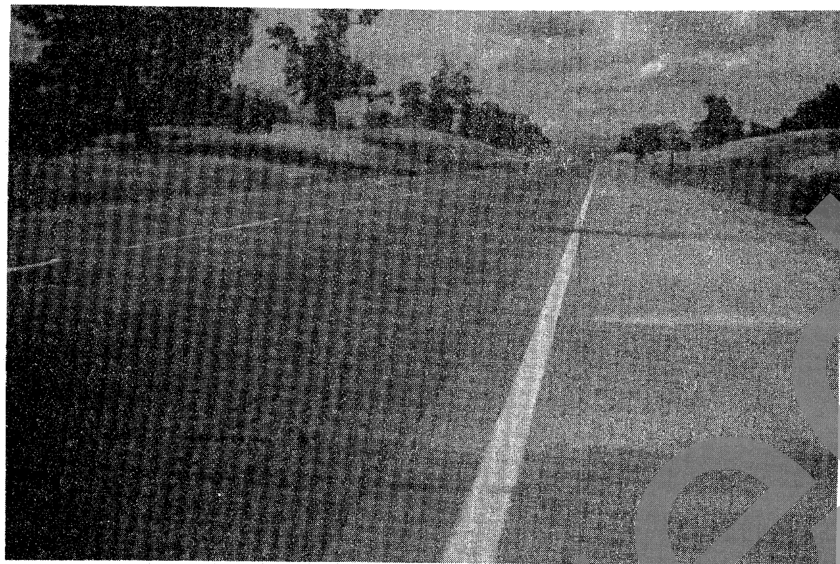

Figure 2.61. High Severity Pumping (stabilized base is pumping).

Figure 2.62. High Severity Pumping (stabilized base is pumping).

Name of Distress: Raveling and Weathering

Description: Raveling and weathering are the wearing away of the pavement surface caused by the dislodging of aggregate particles (raveling) and loss of asphalt binder (weathering). They generally indicate that the asphlat binder has hardened significantly.

Severity Levels:

L - Aggregate or binder has started to wear away, but has not progressed significantly.

M - Aggregate and/or binder has worn away and the surface texture is moderately rough and pitted. Loose particles generally exist.

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

How to Measure: Raveling and weathering are measured in square ft. or square meters of surface area.

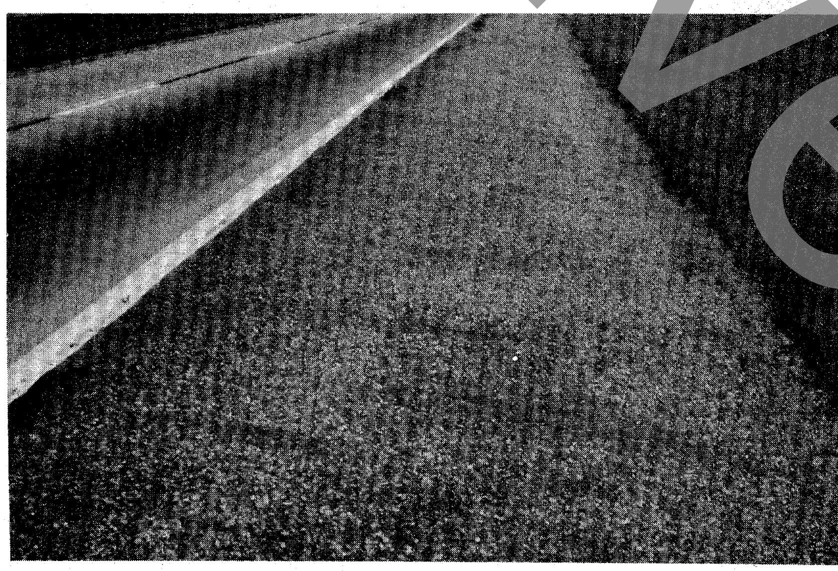

Figure 2.63. Low Severity Raveling and Weathering.

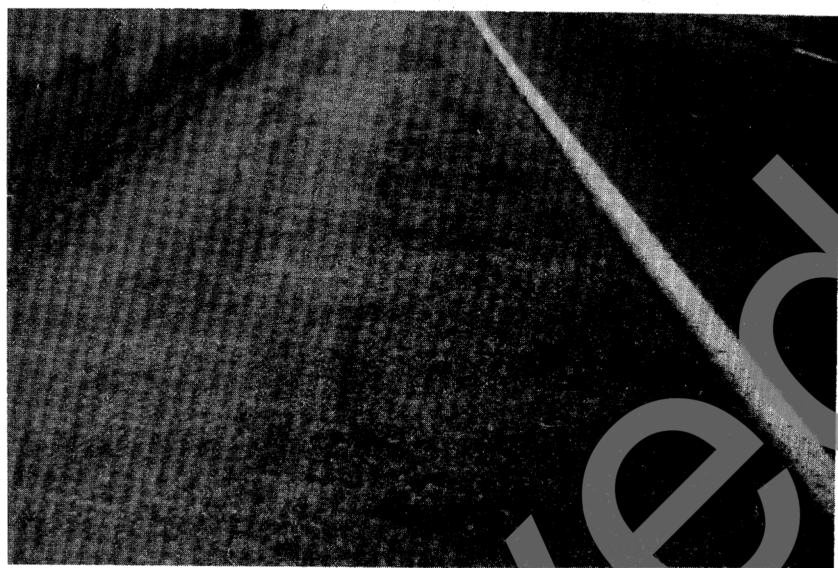

Figure 2.64. Medium Severity Raveling and Weathering.

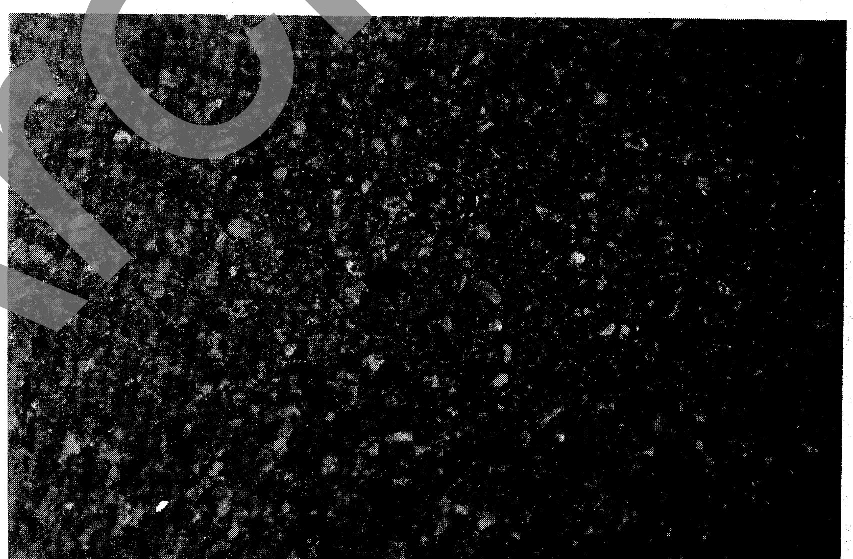

Figure 2.65. Medium Severity Raveling and Weathering.

Figure 2.66. Medium Severity Raveling and Weathering.

Figure 2.67. Medium Severity Raveling and Weathering.

Figure 2.68. High Severity Raveling and Weathering.

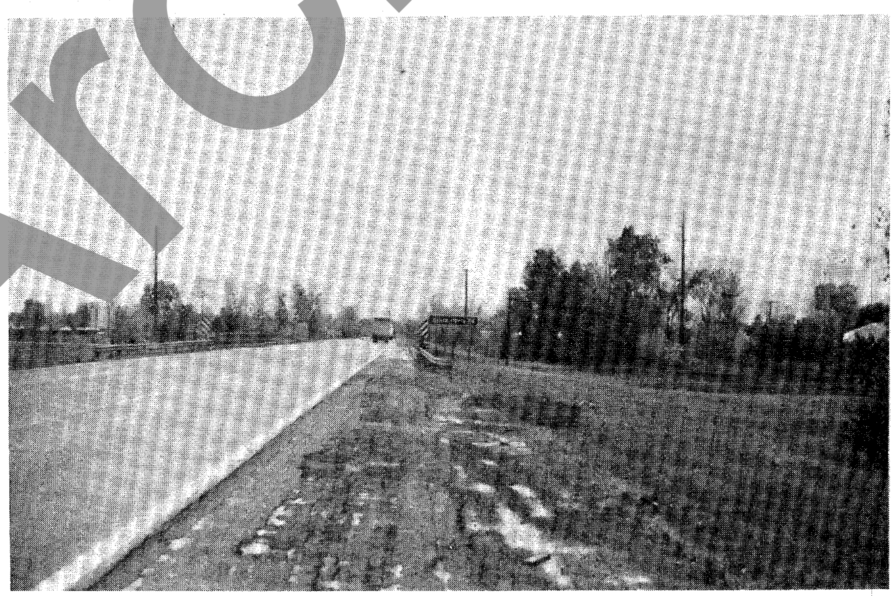

Figure 2.69. High Severity Raveling and Weathering.

Name of Distress: Rutting

Description: A rut is a surface depression in the wheel paths. Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade, usually caused by consolidation or lateral movement of the materials due to traffic laods. Rutting may be caused by plastic movement in the mix in hot weather, or inadequate compaction during construction. Significant rutting can lead to major structural failure of the pavement and hydroplaning potential. Wear of the surface in the wheel paths from studded tires can also cause a type of "rutting."

Severity Levels:

Severity	Mean Rut Depth Criteria
L	1/4 - 1/2 in. (6 - 13 mm)
M	>1/2 - 1 in. (13 - 25 mm)
H	>1 in. (> 25 mm)

How to Measure: Rutting is measured in square feet or square meters of surface area, and its severity is determined by the mean depth of the rut. To determine the mean rut depth, a 4 ft. (1.2 m) straightedge should be laid across the rut and the maximum depth measured. The mean depth should be computed from measurements taken every 20 ft. (6 m) along the length of the rut.

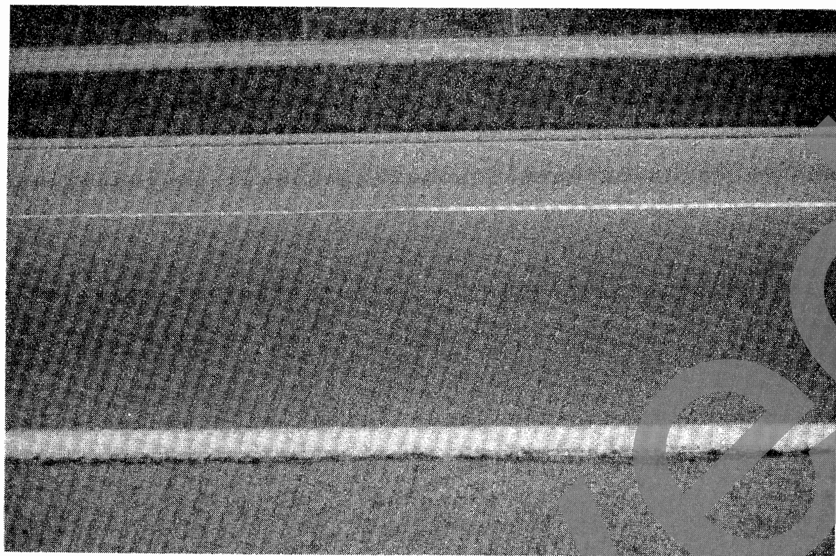

Figure 2.70. Low Severity Rutting.

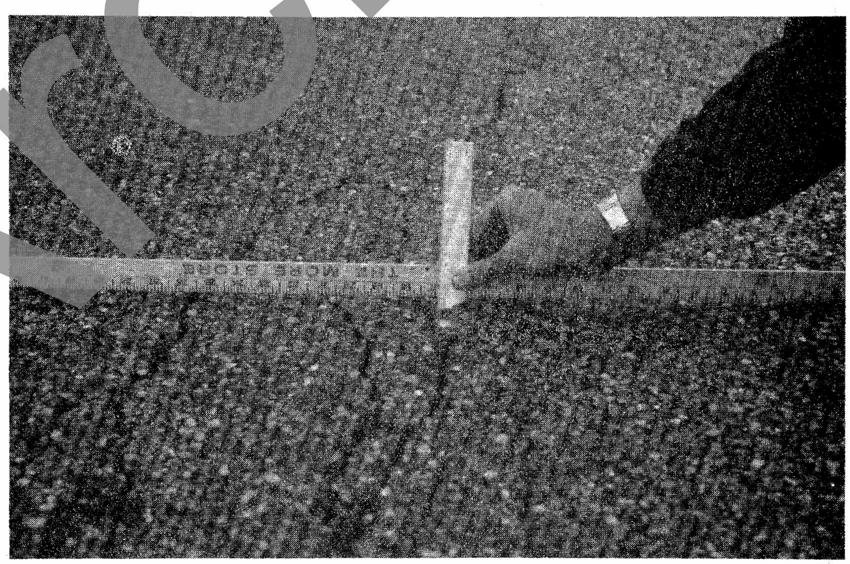

Figure 2.71. Medium Severity Rutting.

Figure 2.72. High Severity Rutting.

Name of Distress: Slippage Cracking

Description: Slippage cracks are crescent or half-moon shaped cracks generally having two ends pointed into the direction of traffic. They are produced when braking or turning wheels cause the pavement surface to slide and deform. This usually occurs when there is a low strength surface mix or poor bond between the surface and next layer of pavement structure.

Severity Levels: No degrees of severity are defined. It is sufficient to indicate that a slippage crack exists.

How to Measure: Slippage cracking is measured in square meters or in square feet of surface area within the inspection unit.

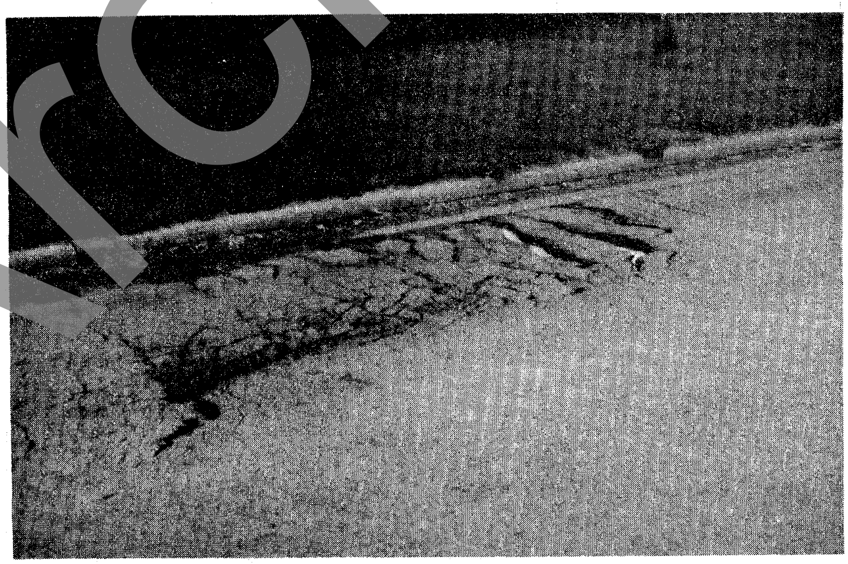

Figure 2.73. Slippage Cracking.

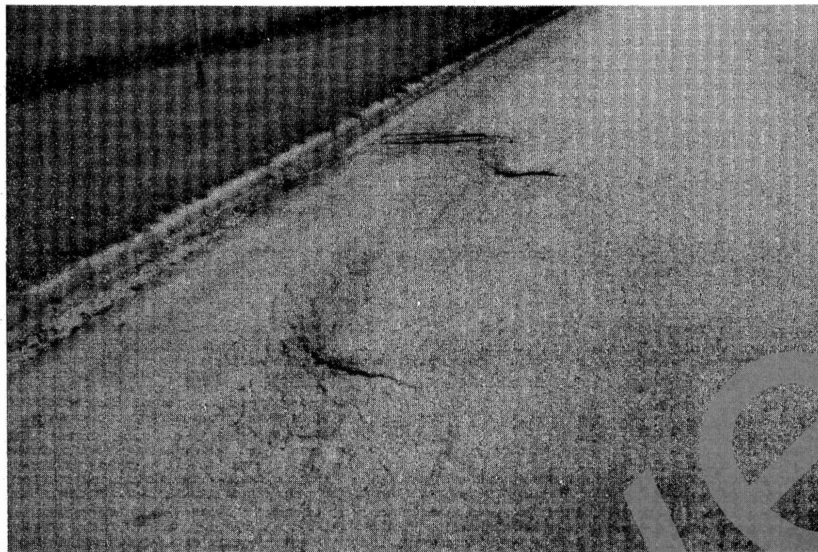

Figure 2.74. Slippage Cracking.

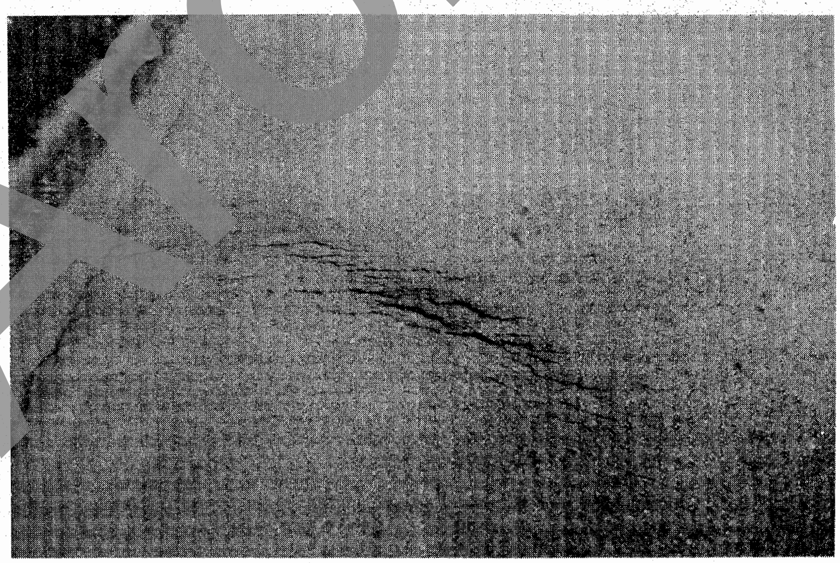

Figure 2.75. Slippage Cracking.

Name of Distress: Swell

Description: Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell can be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil, but a swell can also occur on the surface of an asphalt overlay (over PCC) as a result of a blowup in the PCC slab. They can often be identified by oil droppings on the surface.

Severity Levels:

L - Swell causes some bounce of the vehicle which creates no discomfort.

M - Swell causes significant bounce of the vehicle which creates some discomfort.

H - Swell causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring reduction in speed for safety.

How to Measure: Swells within the inspection unit are measured in square feet or meters. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Figure 2.76. Medium Severity Swell Occurring at a Patch Due to Buckling of Concrete Slab Beneath Asphalt Surface.

Figure 2.77. High Severity Swell Due to Buckling of Concrete Slab Beneath Asphalt Surface.

JOINTED PLAIN CONCRETE DISTRESS

Name of Distress: Blow-up

Description: Blow-ups occur in hot weather at a transverse joint or crack which will not permit expansion of the concrete slabs. The insufficient expansion width of joints is usually caused by infiltration of incompressible materials into the joint space. When compressive expansion pressure cannot be relieved, a localized upward movement of the slab edges (buckling) or shattering occurs in the vicinity of the joint. Blow-ups can also occur at utility cut patches and drainage inlets. Blow-ups are accelerated due to a spalling away of the slab at the bottom creating reduced joint contact area. The presence of "D" cracking also weakens the concrete near the joint resulting in increased spalling and blow-up potential.

Severity Levels:

L - Buckling or shattering has occurred, but only causes some bounce of the vehicle which creates no discomfort.

M - Buckling or shattering causes a significant bounce of the vehicle which creates some discomfort. Temporary patching has been placed because of a blow-up.

H - Buckling or shattering causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Blow-ups are measured by counting the number existing in each inspection unit. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

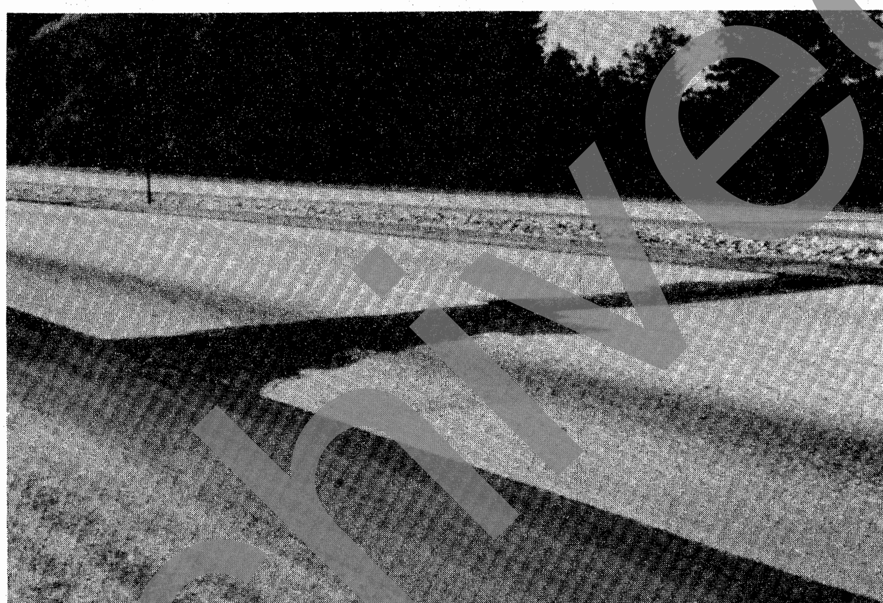

Figure 3.1. Medium Severity Blow-up (temporary patch).

Name of Distress: Corner Break

Description: A corner break is a crack that intersects the joints at a distance less than 6 ft (1.8 m) on either side measured from the corner of the slab. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle. Load repetition combined with loss of support, poor load transfer across joint, and thermal curling and moisture warping stresses usually cause corner breaks.

Severity Levels:

L - Crack is tight (hairline). Well sealed cracks will be considered tight. No faulting or break-up at broken corner exists. Crack is not spalled.

M - Crack is working and spalled at low or medium severity. Break-up of broken corner has not occurred. Faulting of crack or joint must be less than 1/2 inch (13 mm). Temporary patching has been placed because of corner break.

H - Crack is spalled at high severity or the corner piece has broken into two or more pieces. If faulting of crack or joint is more than 1/2 inch (13 mm), it will be considered high severity.

How to Measure: Corner breaks are measured by counting the number that exists in each inspection unit. Different levels of severity should be counted and recorded separately. Corner breaks adjacent to a patch will be counted as patch adjacent slab deterioration.

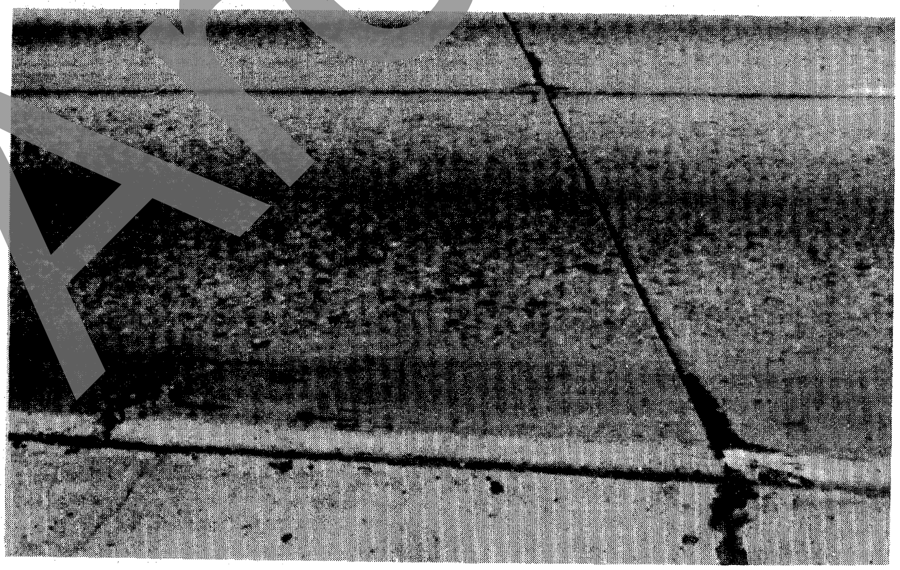

Figure 3.2. Medium Severity Corner Break.

Figure 3.3. Medium Severity Corner Break.

Name of Distress: Depression

Description: Depressions in concrete pavements are surface areas having elevations lower than those of the surrounding pavement. There is generally significant slab cracking in these areas due to uneven settlement. In many instances, light depressions are not noticeable until after a rain when ponding water creates "bird-bath" areas. The depressions may also be located without rain by stains caused by oil droppings from vehicles. Depressions can be caused by settlement or consolidation of the foundation soil or can be "built in" during construction. They are frequently found above culverts. This is usually caused by poor compaction of soil around the culvert during construction. Depressions cause slab cracking, roughness, and hydroplaning when filled with water of sufficient depth.

Severity Levels:

L - Depression causes some bounce of the vehicle which creates no discomfort.

M - Depression causes significant bounce of the vehicle which creates some discomfort.

H - Depression causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Depressions are measured by counting the number that exists in each inspection unit. Each depression is rated according to its level of severity. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lb. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Name of Distress:	Durability ("D") Cracking
Description:	"D" cracking is a series of closely spaced crescent-shaped hairline cracks that appear at a PCC pavement slab surface adjacent and roughly parallel to transverse and longitudinal joints, transverse and longitudinal cracks, and the free edges of pavement slab. The fine surface cracks often curve around the intersection of longitudinal joints/cracks and transverse joints/cracks. These surface cracks often contain calcium hydroxide residue which causes a dark coloring of the crack and immediate surrounding area. This may eventually lead to disintegration of the concrete within 1-2 ft. (0.30-0.6 m) of more of the joint or crack, particularly in the wheelpaths. "D" cracking is caused by freeze-thaw expansive pressures of certain types of coarse aggregates. Concrete durability problems caused by reactive aggregates are rated under "Reactive Aggregate Distress."
Severity Levels:	L - The characteristic crack pattern of closely spaced fine cracks with calcium hydroxide residue appears near joints, cracks, and/or free edges; however, the width of the affected area is generally less than 12 in. wide at the center of the lane in transverse cracks and joints. The crack pattern may fan out at the intersection of transverse cracks/joints with longitudinal cracks/joints. No joint/crack spalling or only minor corner spalling is present.
	M - The characteristic crack pattern of closely spaced cracks had developed near the crack, joint or free edge and is generally wider than 12 in. (30 cm) at the center of the lane in transverse cracks and/or joints. A low or medium severity level of joint/crack or corner spalling has developed in the affected area. Temporary patching has been placed due to "D" cracking induced spalling.
	H - The affected joint or crack has a high severity level of spalling at joints/cracks or corners. Considerable material is loose in the affected area. The crack pattern has developed generally over the entire slab area between cracks and/or joints.
How to Measure:	"D" cracking is measured by counting the number of joints or cracks (including longitudinal) affected. Different severity levels will be counted and recorded separately. "D" cracking adjacent to a patch will be rated as patch-adjacent slab deterioration. "D" cracking should not be counted if the fine crack pattern has not developed near cracks, joints and free edges. Popouts and discoloration of joints, cracks and free edges may occur without "D" cracking.

Figure 3.4. Low Severity "D" Cracking.

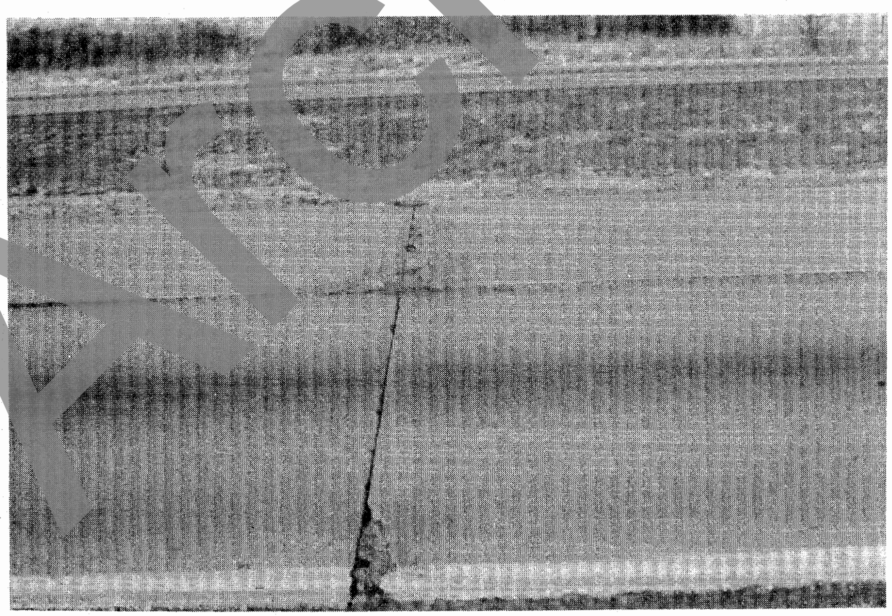

Figure 3.5. Medium Severity "D" Cracking.

Figure 3.6. High Severity "D" Cracking.

Name of Distress: Faulting of Transverse Joints and Cracks

Description: Faulting is the difference of elevation across a joint or crack. Faulting is caused in part by a buildup of loose materials under the approach slab near the joint or crack as well as depression of the leave slab. The buildup of eroded or infiltrated materials is caused by pumping (free moisture under pressure) due to heavy loadings. The warp and/or curl upward of the slab near the joint or crack due to moisture and/or temperature gradient contributes to the pumping condition. Lack of load transfer contributes greatly to faulting.

Severity Levels:

L - Average faulting is equal to or less than 1/16 inch (1.5 mm).

M - Average faulting is more than 1/16 inch (1.5 mm) but less than 1/5 inch (5 mm).

H - Average faulting is equal to or more than 1/5 inch (5 mm).

How to Measure: Faulting is determined by measuring the difference in elevation of slabs at joints for the slabs in the sample unit. Faulting of cracks will be measured and recorded separately. Faulting will be measured one foot in from the outside (right) slab edge on all lanes except the inner passing lane. Faulting will be measured one foot in from the inside (left) slab edge on the inner passing lane.

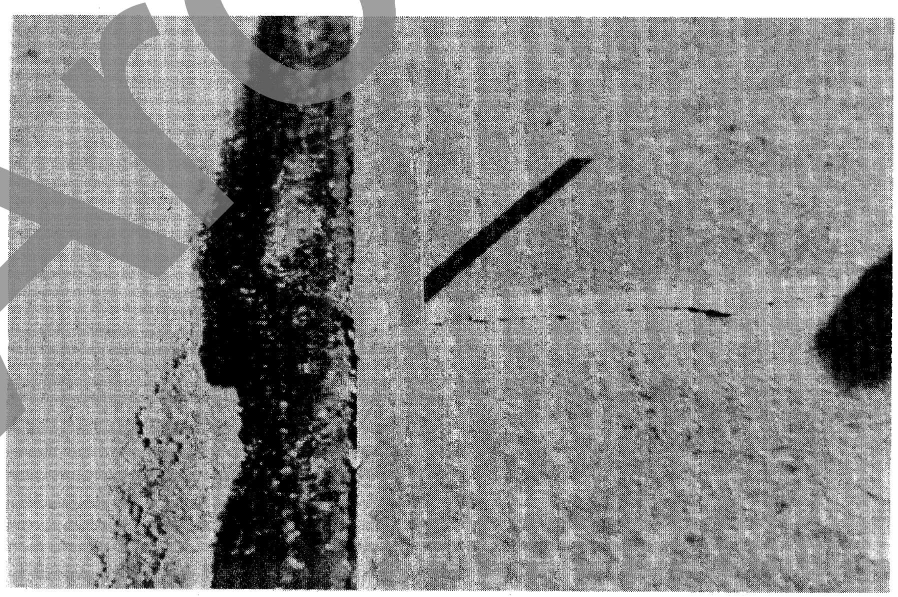

Figure 3.7. Joint Faulting.

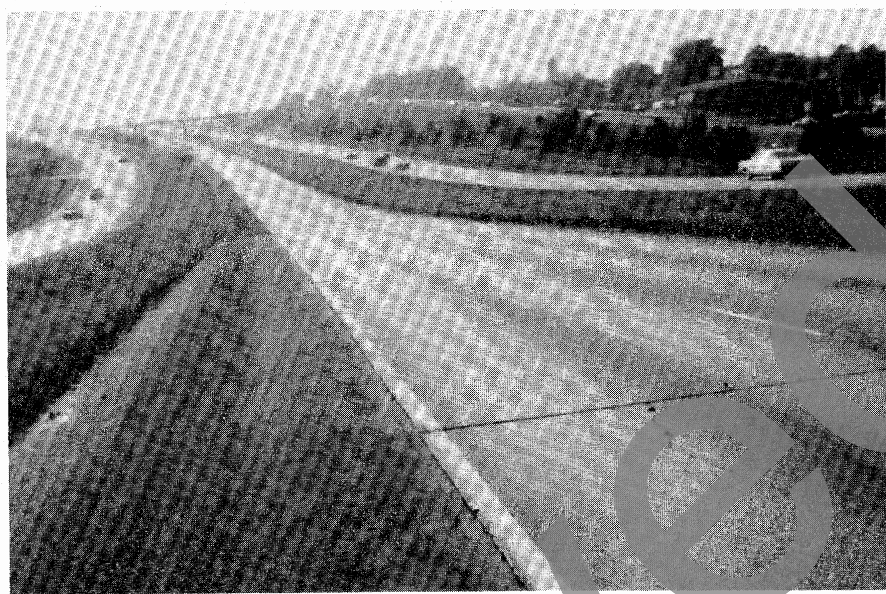

Figure 3.8. Joint Faulting.

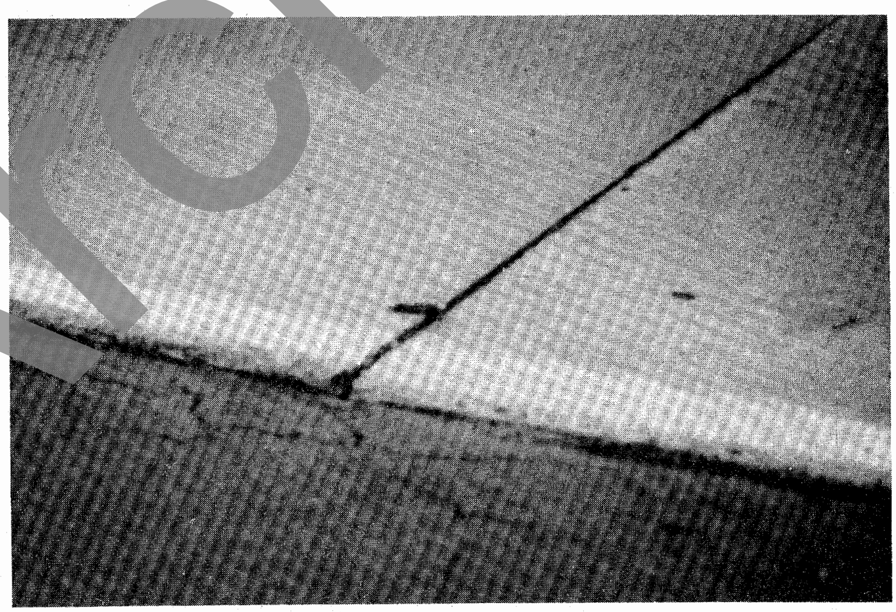

Figure 3.9. Joint Faulting.

Name of Distress: Joint Load Transfer System Associated Deterioration (Second Stage Cracking)

Description: This distress develops as a transverse crack a short distance from a transverse joint, usually at the end of joint load transfer dowels. This usually occurs when the dowel system fails to function properly due to extensive corrosion or misalignment. It may also be caused by a combination of small diameter dowels and heavy traffic loadings.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - The crack has opened to a width less than 1 inch (25 mm); the crack has faulted less than 1/2 inch (13 mm); the crack may have spalled to a low or medium severity level; or the area between the crack and joint has started to break up but pieces have not been dislodged to the point that a tire damage or safety hazard is present. Temporary patches have been placed due to this joint deterioration.

H - A crack with width of opening greater than 1 inch (25 mm); a crack with a high severity level of spalling; a crack faulted 1/2 inch (13 mm) or more; or, the area between the crack and joint has broken up and pieces have been dislodged to the point that a tire damage or safety hazard is present.

How to Measure: The number of joints with each severity level are counted in each inspection unit.

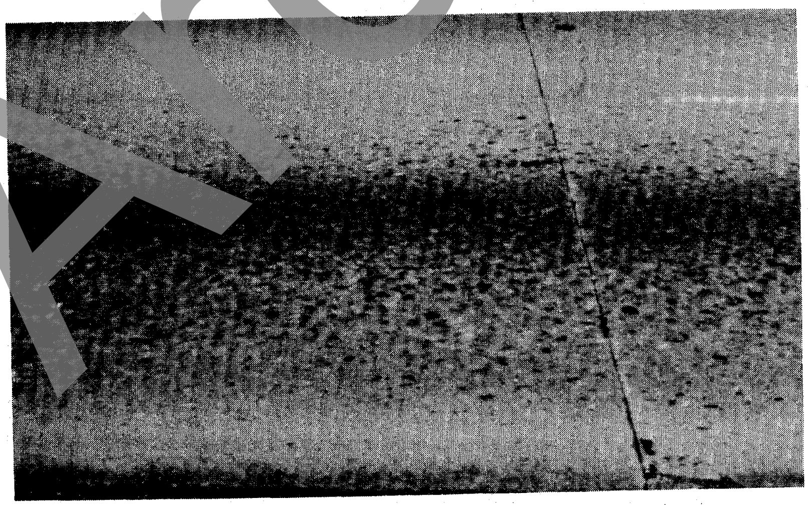

Figure 3.10. Low Severity Joint Load Transfer System Associated Deterioration in Lane at Top of Picture.

Name of Distress: Joint Seal Damage of Transverse Joints

Description: Joint seal damage is any condition which enables incompressible materials to infiltrate into the joints from the surface or allows significant infiltration of water. Accumulation of incompressible materials within the joints restricts in-slab expansion and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protect the joints from accumulation of incompressible materials, and also reduces the amount of water seeping into the pavement structure. Typical types of joint seal damage are: (1) stripping of joint sealant, (2) extrusion of joint sealant, (3) weed growth, (4) hardening of the filler (oxidation), (5) loss of bond to the slab edges, and (6) lack or absence of sealant in the joint.

Severity Levels:

L - Joint sealer is in generally good condition throughout the section. Sealant is performing well with only a minor amount of any of the above types of damage present. Little water and no incompressibles can infiltrate through the joint.

M - Joint sealer is in generally fair condition over the entire surveyed section, with one or more of the above types of damage occurring to a moderate degree. Water can infiltrate the joint fairly easily; some incompressibles can infiltrate the joint. Sealant needs replacement within 3 years.

H - Joint sealer is in generally poor condition over the entire surveyed section, with one or more of the above types of damage occurring to a severe degree. Water and incompressibles can freely infiltrate the joint. Sealant needs immediate replacement.

How to Measure: Joint seal damage of transverse joints is rated based on the overall condition of the sealant over the entire inspection unit.

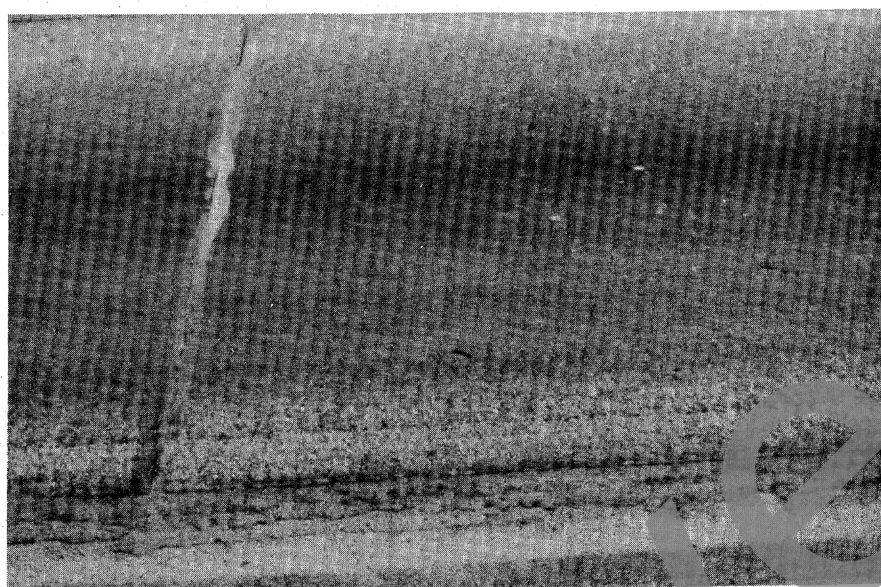

Figure 3.11. Low Severity Joint Sealant Damage.

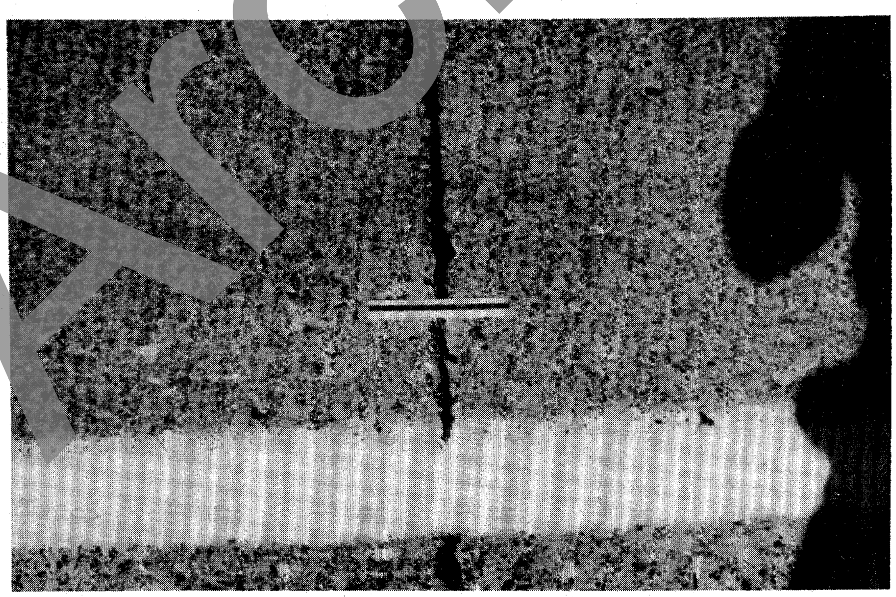

Figure 3.12. Medium Severity Joint Sealant Damage.

Figure 3.13. High Severity Joint Sealant Damage (sealant generally missing).

Name of Distress: Lane/Shoulder Dropoff or Heave

Description: Lane/Shoulder dropoff or heave occurs wherever there is a difference in elevation between the traffic lane and shoulder. Typically the outside shoulder settles due to consolidation or a settlement of the underlying granular or subgrade material, or pumping of the underlying material. Heave of the shoulder may occur due to frost action or swelling soils. Dropoff of granular or soil shoulder is generally caused from blowing away of shoulder material from passing trucks.

Severity Level: Severity level is determined by computing the mean difference in elevation between the traffic lane and shoulder:

L	1/4 - 1/2 in.	(6 - 13 mm)
M	1/2 - 1 in.	(3 - 25 mm)
H	> 1 in.	(> 25 mm)

How to Measure: Lane/shoulder dropoff or heave is measured every 100 ft. (30 m) in inches (or mm) along the joint. The mean difference in elevation is computed from the data and used to determine severity level.

Figure 3.14. Lane/Shoulder Dropoff.

Figure 3.15. Lane/Shoulder Heave.

Name of Distress: Lane/Shoulder Joint Separation

Description: Lane/shoulder joint separation is the widening of the joint between the traffic lane and the shoulder generally due to movement in the shoulder. If the joint is tightly closed or well sealed so that water cannot easily infiltrate, then lane/shoulder joint separation is not considered a distress.

Severity Level: No severity level is counted if the joint is tightly sealed.

L - Some opening but less than or equal to 0.12 inch (3 mm).

M - More than 0.12 inch (3 mm) but equal to or less than 0.4 inch (10 mm) opening.

H - More than 0.4 inch (10 mm) opening.

How to Measure: Lane/shoulder joint separation is measured and recorded in inches (or mm) near transverse joints and at mid slab. The mean separation is used to determine the severity level.

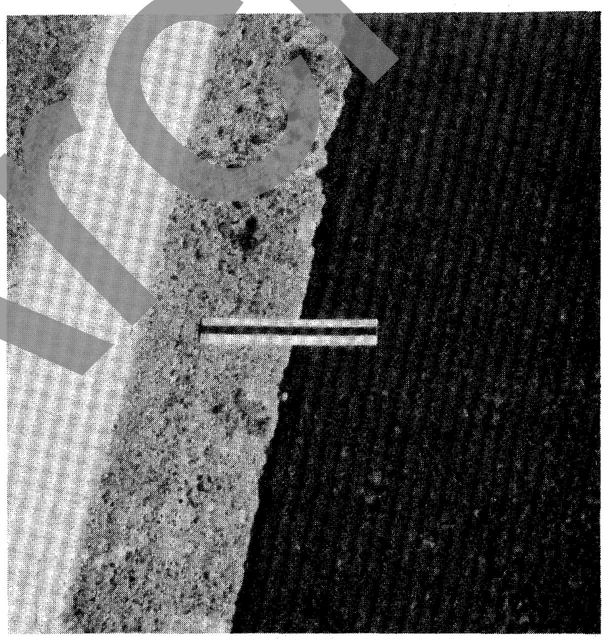

Figure 3.16. Low Severity Lane/Shoulder Separation.

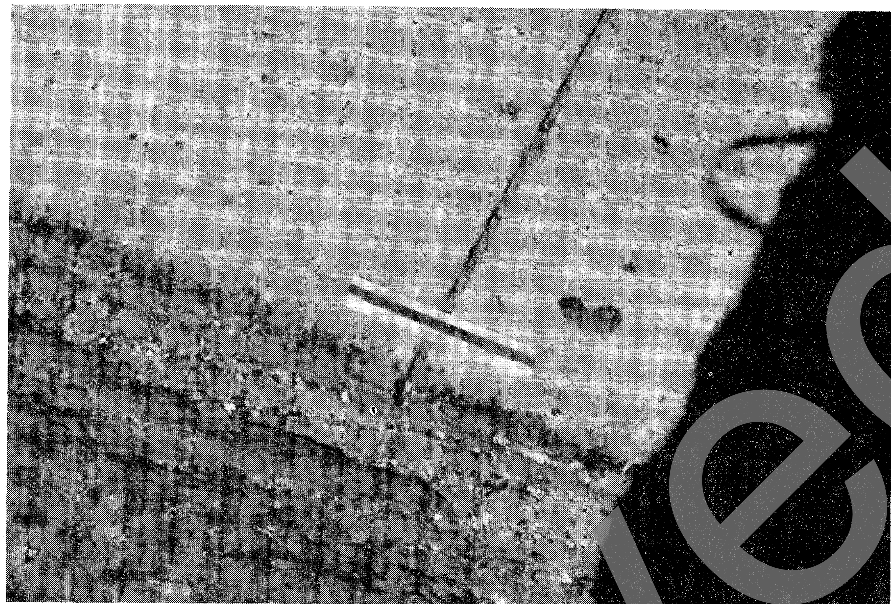

Figure 3.17. High Severity Lane/ Shoulder Separation.

Figure 3.18. Gravel Shoulder Recorded as High Severity Lane/ Shoulder Separation.

Name of Distress: Longitudinal Cracks

Description: Longitudinal cracks occur generally parallel to the centerline of the pavement. They are often caused by improper construction of longitudinal joints, or by a combination of heavy load repetition, loss of foundation support, and thermal and moisture gradient stresses.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - Working crack with a moderate or less severity level of spalling and/or faulting less than 1/2 inch (13 mm).

H - A crack with width greater than 1 inch (25 mm); a crack with a high severity level of spalling; or, a crack faulted 1/2 inch (13 mm) or more.

How to Measure: Cracks are measured in linear feet or meters for each level of distress. The length and severity of each crack should be identified and recorded. If the crack does not have the same severity level along the entire length, each general portion of the crack having a different severity level should be recorded separately.

Figure 3.19. Low Severity Longitudinal Crack.

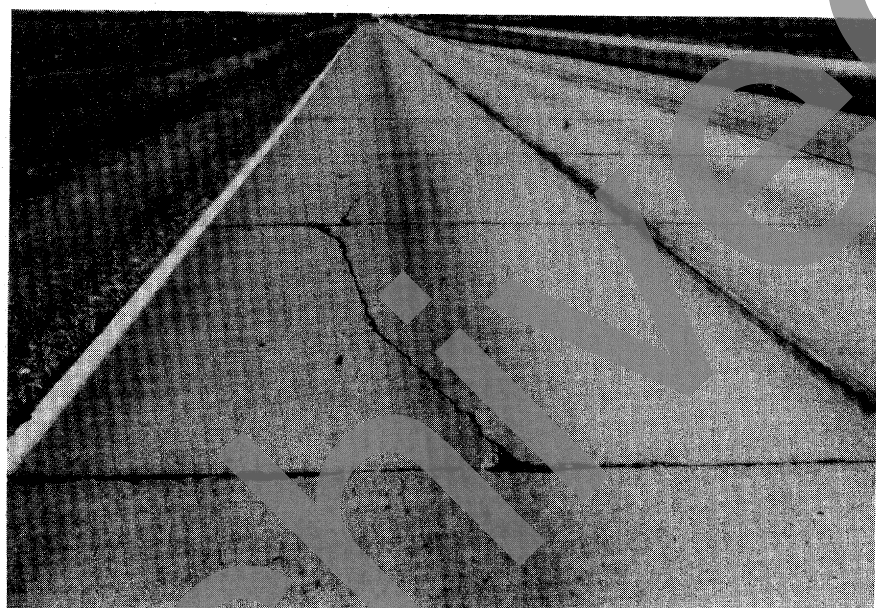

Figure 3.20. Medium Severity Longitudinal Crack.

Name of Distress: Longitudinal Joint Faulting

Description: Longitudinal joint faulting is a difference in elevation at the longitudinal joint between two traffic lanes.

Severity Levels:
L - Some faulting but less than 1/4 inch (6 mm).

M - Faulting of 1/4 inch (6 mm) to 1/2 inch (13 mm).

H - Faulting of 1/2 inch (13 mm) or more

How to Measure: Where the longitudinal joint has faulted, the length of the affected area and the maximum joint faulting will be recorded.

Figure 3.21. Longitudinal Joint Faulting.

Name of Distress: Patch Deterioration

Description: A patch is an area where the original pavement has been removed and replaced by either similar or different material (i.e., concrete or asphalt). Only permanent patches should be considered.

Severity Levels:

L - Patch is functioning well with little or no deterioration. Some low severity spalling of the patch edges may exist. Faulting across the slab-patch joint must be less than 1/4 inch (6 mm). Patch is rated low severity even if it is in excellent condition.

M - Patch has cracked (low severity level) and/or some spalling of medium severity level exists around the edges. Minor rutting may be present. Faulting at 1/4 to 3/4 inch (6-19 mm) exists. Temporary patches have been placed because of permanent patch deterioration.

H - Patch has deteriorated, either by spalling of the patch rutting or cracking within the patch, to a condition which requires replacement.

How to Measure: The number of patches within each sample unit is recorded. Patches at different severity levels are counted and recorded separately. Additionally, the approximate square footage (or meters) of each patch and type (i.e., PCC or asphalt) is recorded. Location of the patch should be identified (joint or slab). All patches are rated either L, M, or H.

Figure 3.22. Low Severity PCC Patch Deterioration.

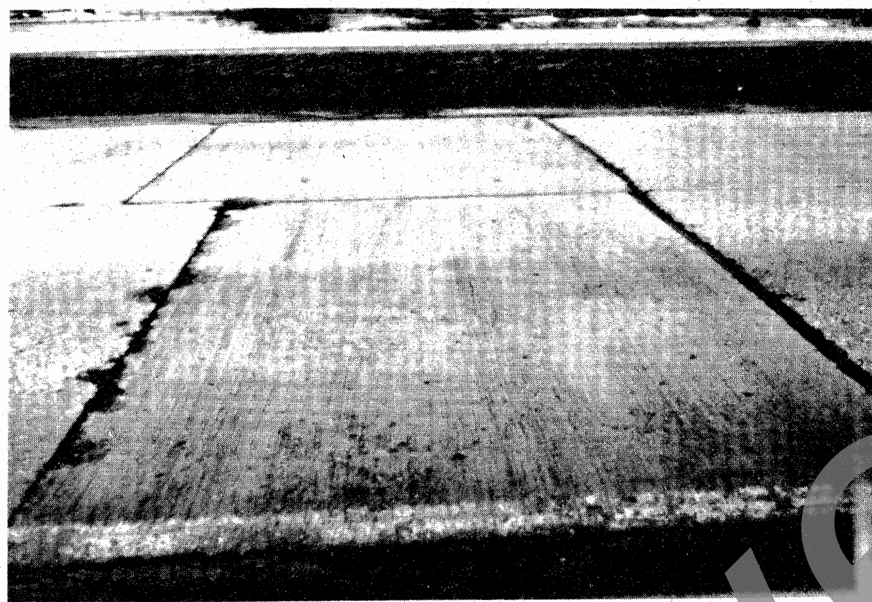

Figure 3.23. Medium Severity PCC Patch Deterioration.

Figure 3.24. Low Severity Asphalt Patch Deterioration.

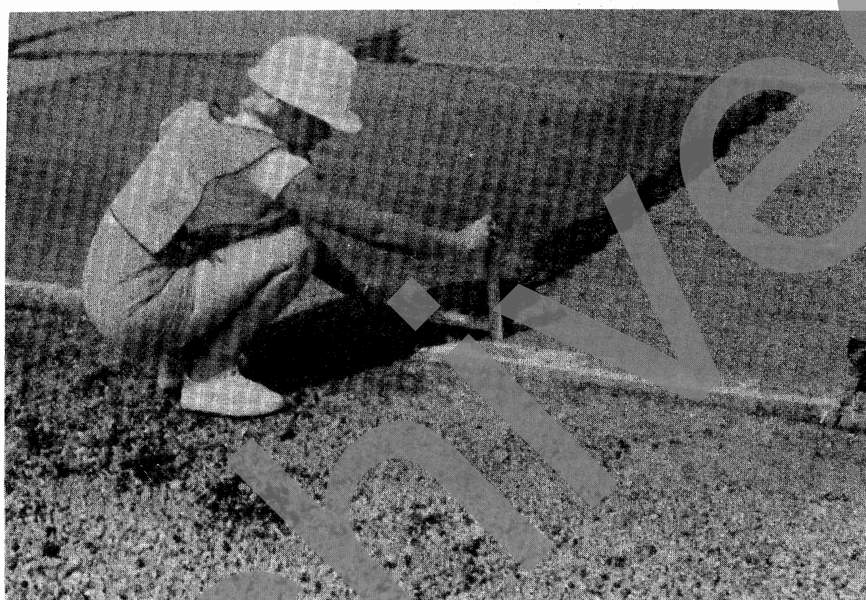

Figure 3.25. Medium Severity Asphalt Patch Deterioration.

Name of Distress:	Patch Adjacent Slab Deterioration
Description:	Deterioration of the original concrete slab adjacent to a permanent patch is given the above name. This may be in the form of spalling of the slab at the slab/patch joint, "D" cracking of the slab adjacent to the patch, a corner break in the adjacent slab, or a second permanent patch placed adjacent to the original patch.
Severity Levels:	Severity levels are the same as that described for the particular distress found. A second permanent patch placed adjacent to a previously placed permanent patch will be rated as medium severity. Temporary patches placed because of this deterioration will also be rated as medium severity.
How to Measure:	The number of permanent patches with distress in the original slab adjacent to the patch at each severity level will be counted and recorded separately. Additionally, the type of patch (AC or PCC) and distress will be recorded separately, along with the location (joint or slab).

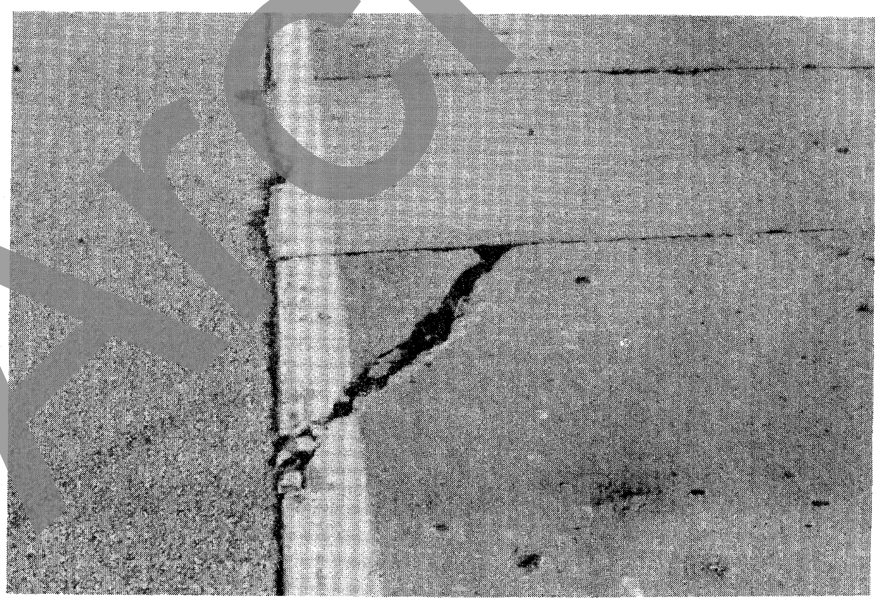

Figure 3.26. Patch Adjacent Slab Deterioration.

Name of Distress: Popouts

Description: A popout is a small piece of concrete that breaks loose from the pavement surface due to freeze-thaw action, expansive aggregates, or nondurable aggregates. The occurrence of extensive popouts may be indicative of unsound aggregates and "D" cracking. Popouts usually range from approximately 1 inch (25 mm) to 4 inch (10 cm) in diameter and from 1/2 inch to 2 inch (13-51 mm) deep.

Severity Levels: No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; i.e., average popout density must exceed approximately one popout per square yard (square meter) over the entire slab area.

How to Measure: The density of popouts can be determined by counting the number of popouts per square yard of surface in areas having typical amounts.

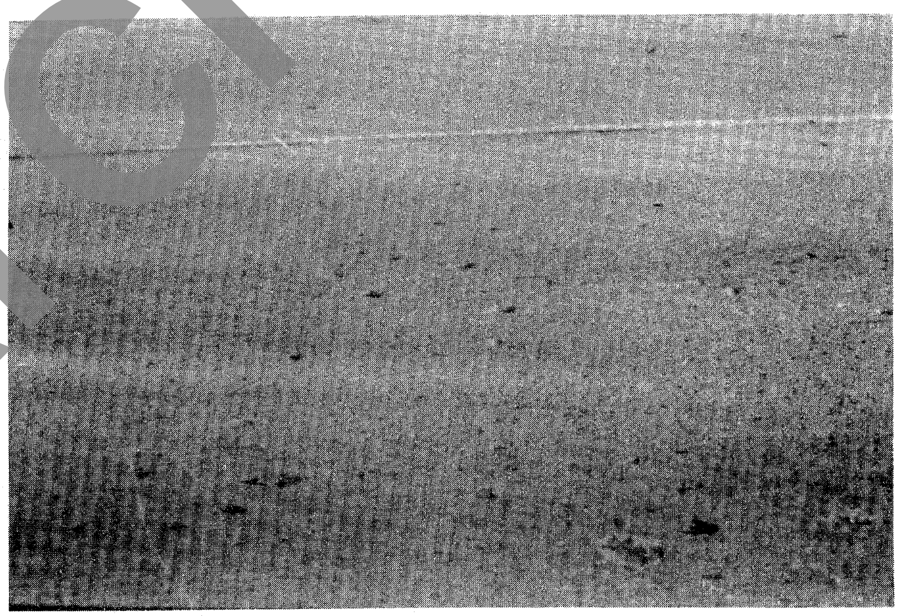

Figure 3.27. Popouts.

Name of Distress: Pumping and Water Bleeding

Description: Pumping is the ejection of material by water through joints or cracks, caused by deflection of the slab under moving loads. As the water is ejected, it carries particles of gravel, sand clay, or silt, resulting in a progressive loss of pavement support. Surface staining or accumulation of base or subgrade material on the pavement surface close to joints or cracks is evidence of pumping. Pumping can occur without such evidence, particularly when stabilized bases are used. The observation of water being ejected by heavy traffic loads after a rain storm can also be used to identify pumping. Water bleeding occurs when water seeps out of joints or cracks.

Severity Levels:

L - Water is forced our of a joint or crack when trucks pass over the joints or cracks, water is forced out of the lane/shoulder joint when trucks pass along the joint, or water bleeding exists. No fines can be seen on the surface of the traffic lanes or shoulder.

M - A small amount of pumped material can be observed near some of the joints or cracks on the surface of the traffic lane or shoulder.

H - A significant amount of pumped materials exist on the pavement surface of the traffic lane or shoulder along the joints or cracks.

How to Measure: If pumping or water bleeding exists anywhere in the sample unit it is counted as occurring at highest severity level noted.

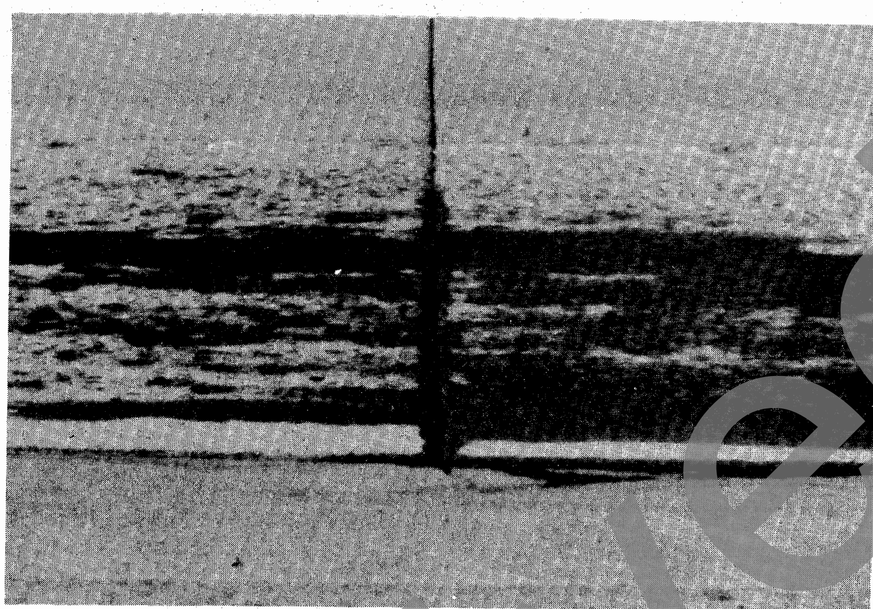

Figure 3.28. Low Severity Pumping.

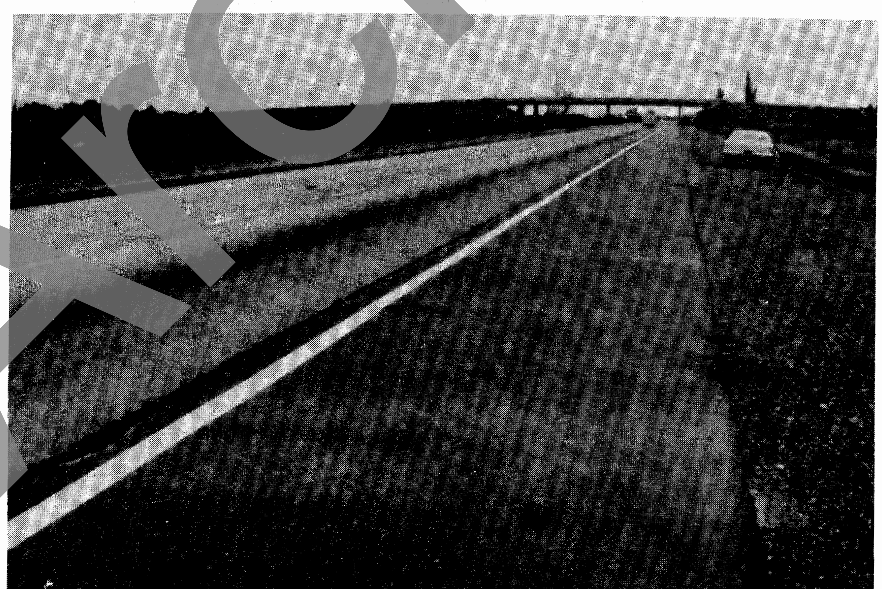

Figure 3.29. Medium Severity Pumping.

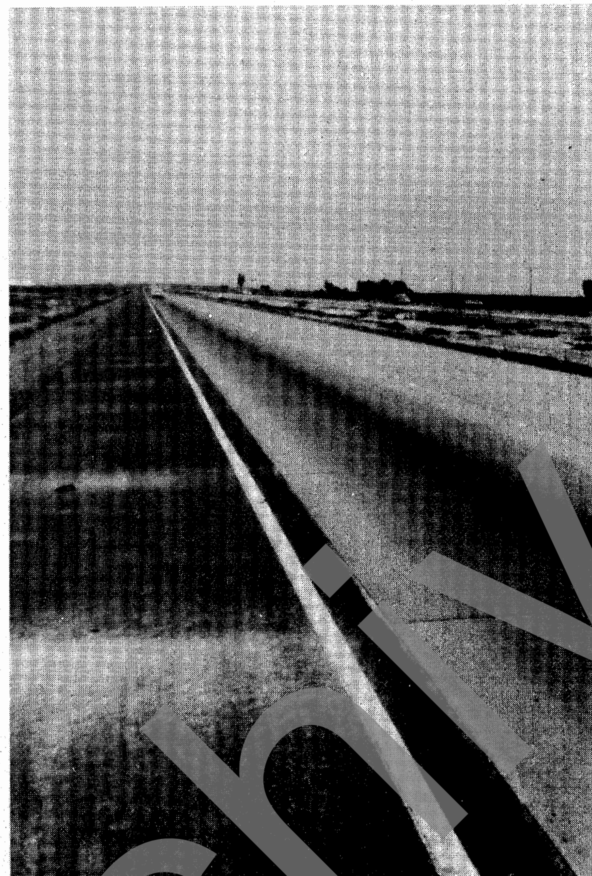

Figure 3.30. High Severity Pumping.

Name of Distress: Reactive Aggregate Distress

Description: Reactive aggregates either expand in alkaline environments or develop prominent siliceous reaction rims in concrete. It may be an alkali-silica reaction or an alkali-carbonate reaction. As expansion occurs, the cement matrix is disrupted and cracks. It appears as a map cracked area; however, the cracks may go deeper into the concrete than in normal map cracking. It may affect most of the slab or it may first appear at joints and cracks.

Severity Levels: Only one level of severity is defined. If alkali-aggregate cracking occurs anywhere in the slab, it is counted. If the reaction has caused spalling or map cracking, these also are counted.

How to Measure: Reactive-aggregate distress is measured in square feet or square meters.

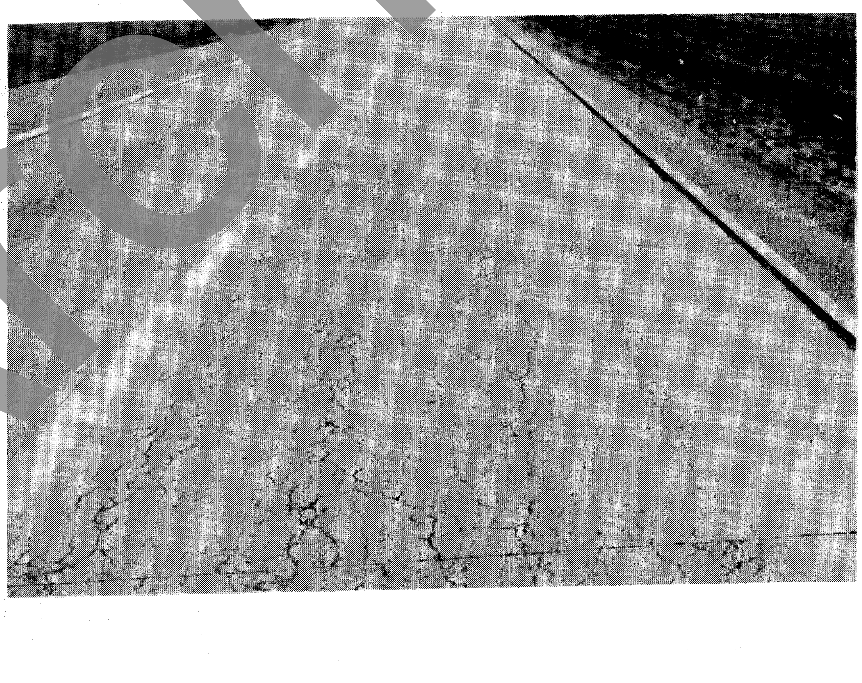

Figure 3.31. Reactive Aggregate Distress.

Name of Distress: Scaling, Map Cracking, and Crazing

Description: Map cracking or crazing refers to a network of shallow, fine, or hairline cracks which extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Map cracking or crazing is usually caused by over-finishing the concrete, and may lead to scaling of the surface, which is the breakdown of the slab surface to a depth of approximately 1/4 in. (6 mm) to 1/2 in. (13 mm). Scaling may be caused by deicing salts, traffic, improper construction, freeze-thaw cycles, and steel reinforcement too close to the surface.

Severity Levels:

L - Crazing or map cracking exists over most of the slab area; the surface is in good condition with no scaling. (Note: the low severity level is an indicator that scaling may develop in the future).

M - Less than 10% of any slab exhibits scaling.

H - More than 10% of any slab exhibits scaling.

How to Measure: Scaling, map cracking, and crazing are measured by recording % of area affected by each type severity level.

Figure 3.32. Scaling.

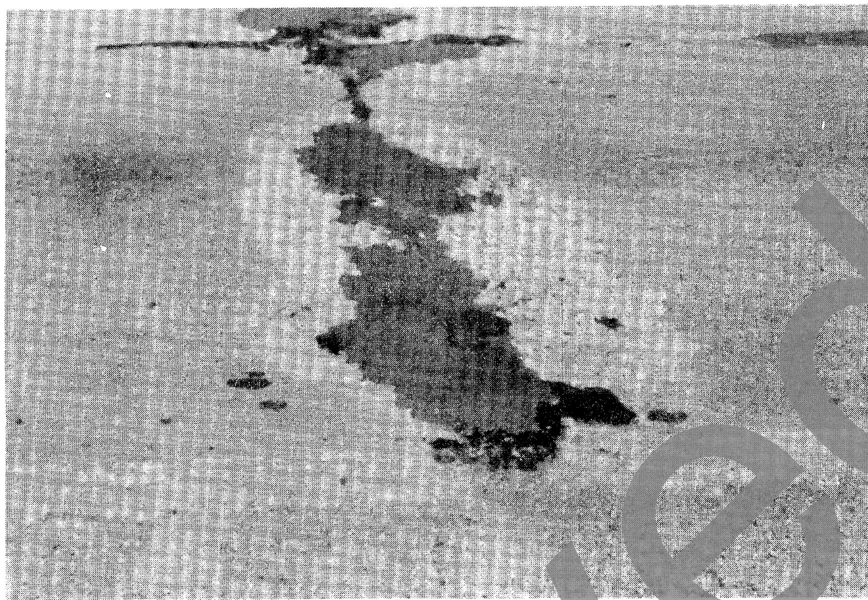

Figure 3.33. Scaling Near Transverse Joint.

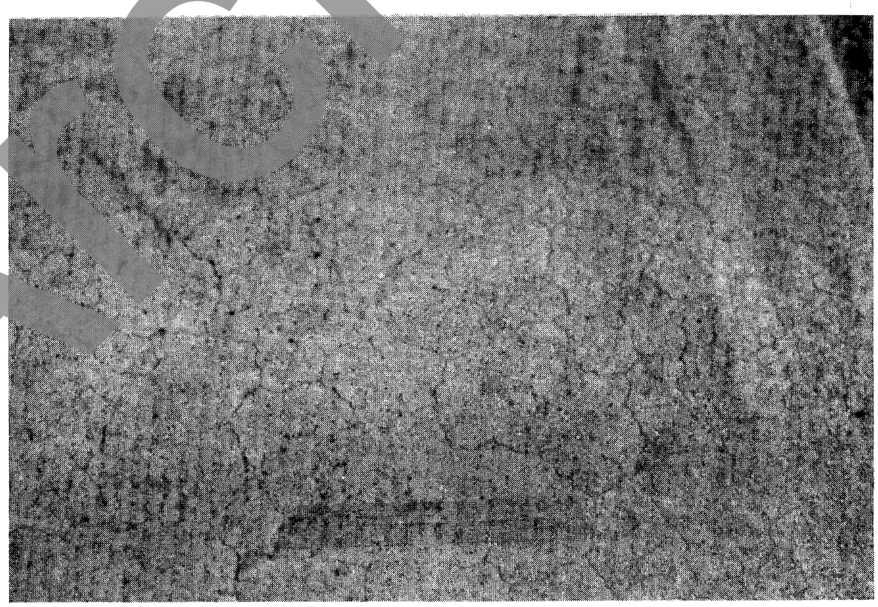

Figure 3.34. Map Cracking or Crazing.

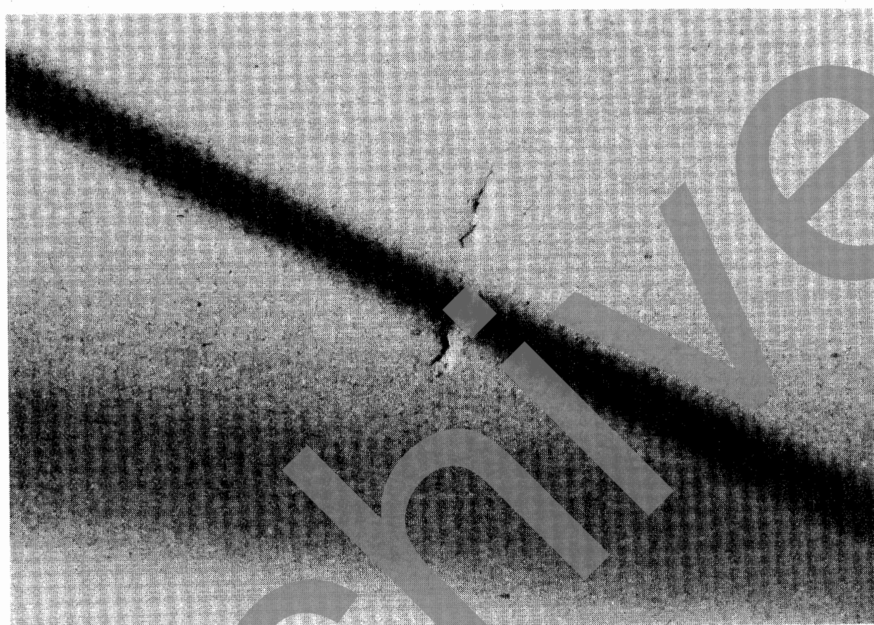

Figure 3.35. Map Cracking or Crazing.

Name of Distress: Spalling (Transverse and Longitudinal Joint/Crack)

Description: Spalling of cracks and joints is the cracking, breaking or chipping of the slab edges within 2 ft. (0.6 m) of the joint. A joint spall usually does not extend vertically through the whole slab thickness, but extends to intersect the joint at an angle. Spalling usually results from (1) excessive stresses at the joint or crack caused by infiltration of incompressible materials and subsequent expansion or traffic loading, (2) disintegration of the concrete, (3) weak concrete at the joint (caused by over-working) combined with traffic loads, or (4) poorly designed or constructed load transfer device.

Severity Levels:

L - A spall less than two feet long; if spall is broken into pieces and fragmented, it must not extend more than three inches from the joint or crack. A spall more than two feet long with spall held tightly in place; if spall is cracked, it cannot be broken into more than three pieces. The joint is lightly frayed with fray extending no more than three inches from the edge of the joint or crack.

M - A spall is broken into pieces or fragmented and spall extends more than three inches from joint or crack. Some pieces may be loose and/or missing but the spalled area does not present a tire damage or safety hazard. The joint or crack is moderately frayed with fray extending more than three inches from the edge of the joint or crack but not causing a tire damage or safety hazard. Temporary patching has been placed because of spalling.

H - The joint is severely spalled or frayed to the extent that a tire damage or safety hazard exists.

How to Measure: Spalling is measured by counting and recording separately the number of joints with each severity level. If more than one level of severity exists along a joint, it will be recorded as containing the highest severity level present. Although the definition and severity levels are the same, spalling of cracks should not be recorded separately. The spalling of cracks is included in rating severity levels of cracks. Spalling of transverse and longitudinal joints will be recorded separately. Spalling of the slab edge adjacent to a permanent patch will be recorded as patch adjacent slab deterioration.

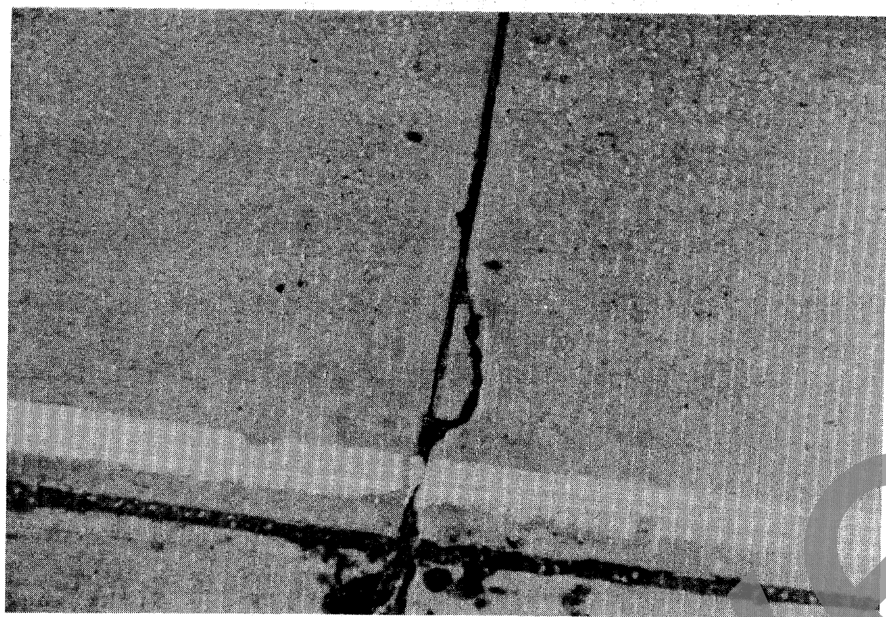

Figure 3.36. Low Severity Spalling (Transverse Joint).

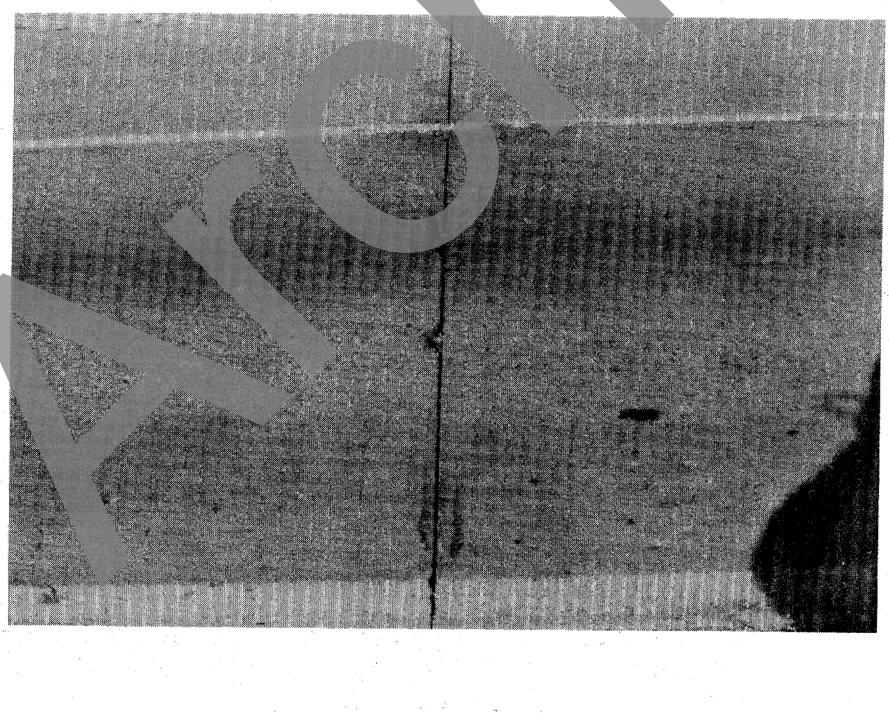

Figure 3.37. Low Severity Spalling (Transverse Joint).

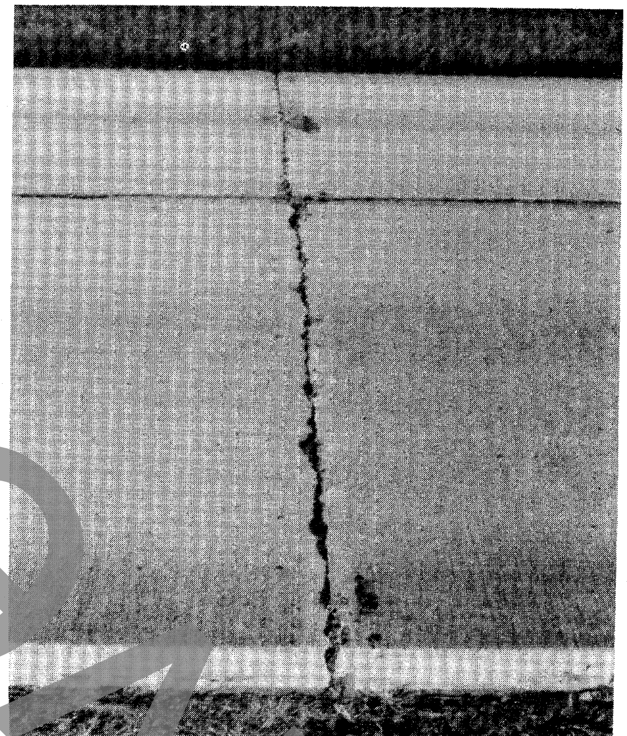

Figure 3.38. Low Severity Spalling (Transverse Joint).

Figure 3.39. Medium Severity Spalling (Transverse Joint).

Figure 3.40. Medium Severity Spalling (Transverse Joint).

Figure 3.41. Medium Severity Spalling (Transverse Joint).

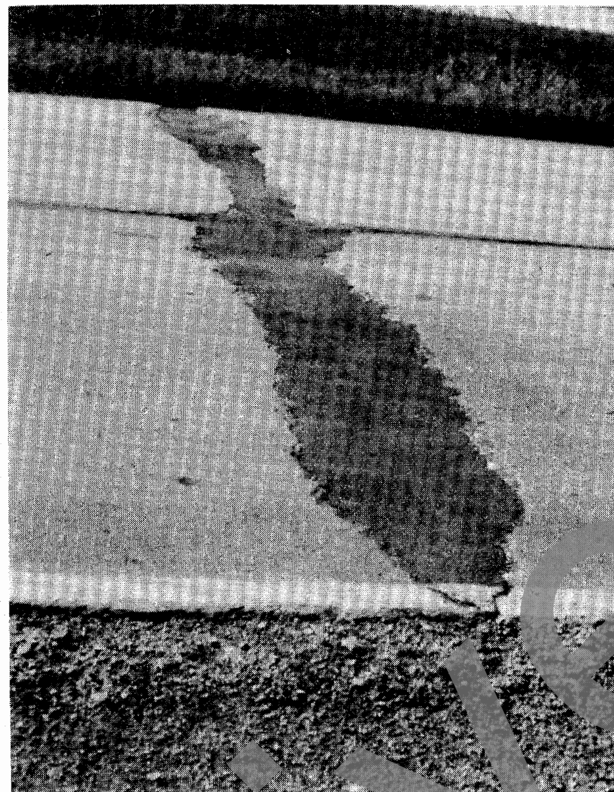

Figure 3.42. Medium Severity Spalling (Transverse Joint).

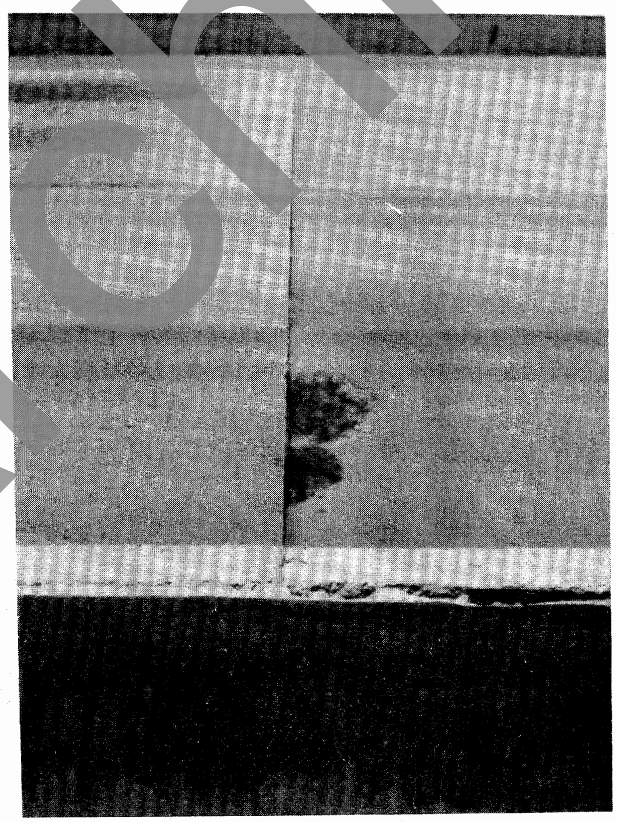

Figure 3.43. High Severity Spalling (Transverse Joint) (safety hazard).

Name of Distress: Spalling (Corner)

Description: Corner spalling is the ravelling or breakdown of the slab within approximately 2 ft (0.6 m) of the corner. A corner spall differs from a corner break in that the spall usually angles downward at about 45° to intersect the joint, while a break extends vertically through the slab. Corner spalling can be caused by freeze-thaw, "D" cracking, and other factors.

Severity Level:

L - Spall is not broken into pieces. No spalling of cracks exists. Spall is in place and is not loose. Corner spalls with both edges less than 3 inches long will not be counted.

M - One of the following conditions exists: Spall is broken into pieces; cracks are spalled; some or all pieces are loose or absent but do not present tire damage or safety hazard. Corner spall is patched.

H - Spall is broken into and/or pieces of the spall have displaced to the extent that they present a tire damage or safety hazard.

How to Measure: Corner spalling is measured by counting and recording separately the number of corners spalled at each severity level within the inspection unit.

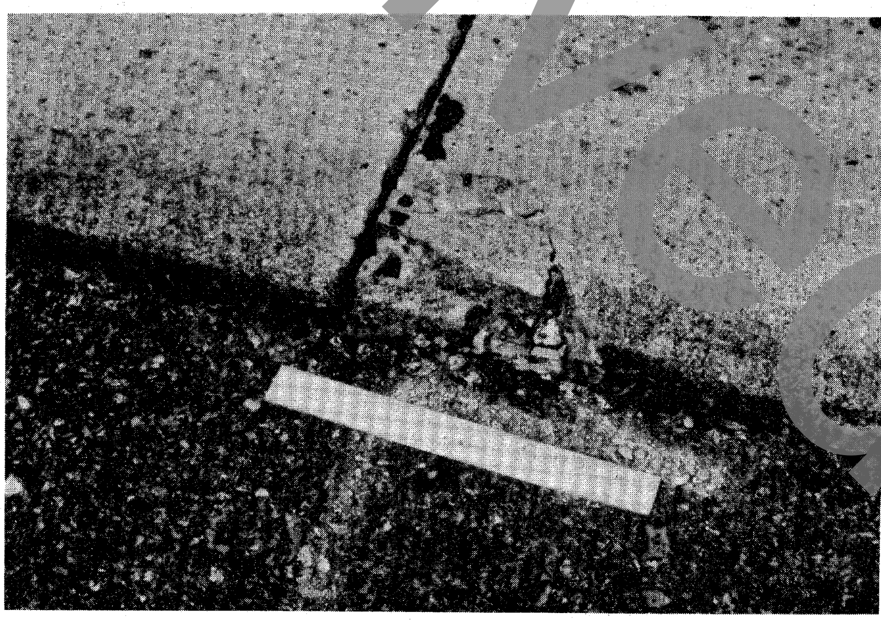

Figure 3.44. Low Severity Corner Spalling.

Figure 3.45. Medium Severity Corner Spalling.

Name of Distress: Swell

Description: Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell is usually accompanied by slab cracking. A swell is usually caused by frost action in the subgrade or by swelling soil. Swells can often be identified by oil droppings on the surface.

Severity Levels:

L - Swell causes some bounce of the vehicle which creates no discomfort.

M - Swell causes significant bounce of the vehicle which creates some discomfort.

H - Swell causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: The number of swells within the inspection unit are counted and recorded by severity level. Severity levels are determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

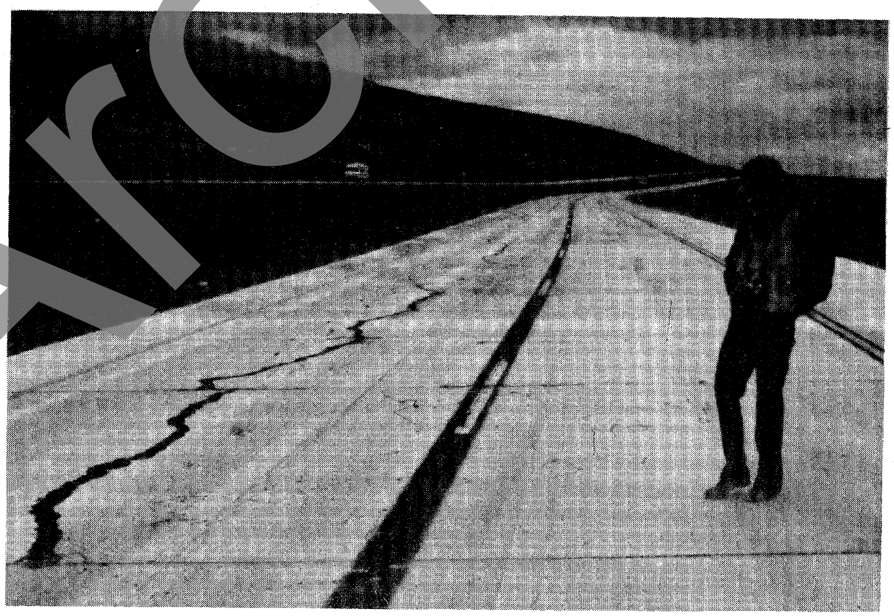

Figure 3.46. Swell Due to Frost Heave.

Figure 3.47. Swell Due to Frost Heave located in same area as Figure 3.46(a cut area).

Name of Distress: Transverse and Diagonal Cracks

Description: These cracks are usually caused by a combination of heavy load repetition, thermal and moisture gradient stresses, and drying shrinkage stresses. Medium or high severity cracks are working cracks and are considered major structural distresses. (Note: hairline cracks that are less than 6 feet (1.8 m) long are not rated.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - Working crack with a medium severity level of spalling and/or faulting less than 1/2 inch (13 mm).

H - A crack with width of opening greater than 1 inch (25 mm); a crack with a high severity level of spalling; or, a crack faulted 1/2 inch (13 mm) or more.

How to Measure: The number and severity level of each crack should be identified and recorded. If the crack does not have the same severity level along the entire length, the crack will be rated as the highest severity level present. Cracks in patches will be recorded as patch deterioration.

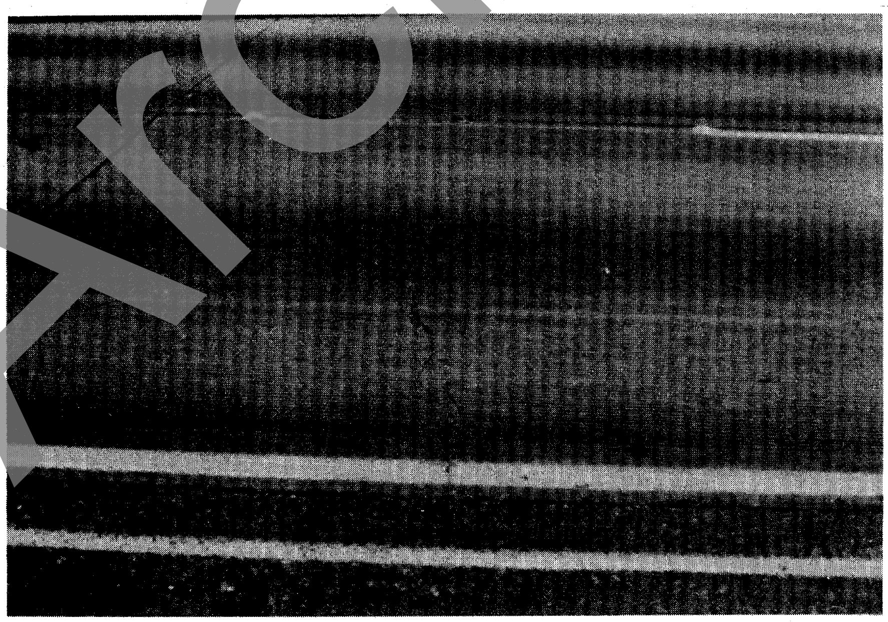

Figure 3.48. Low Severity Transverse Crack.

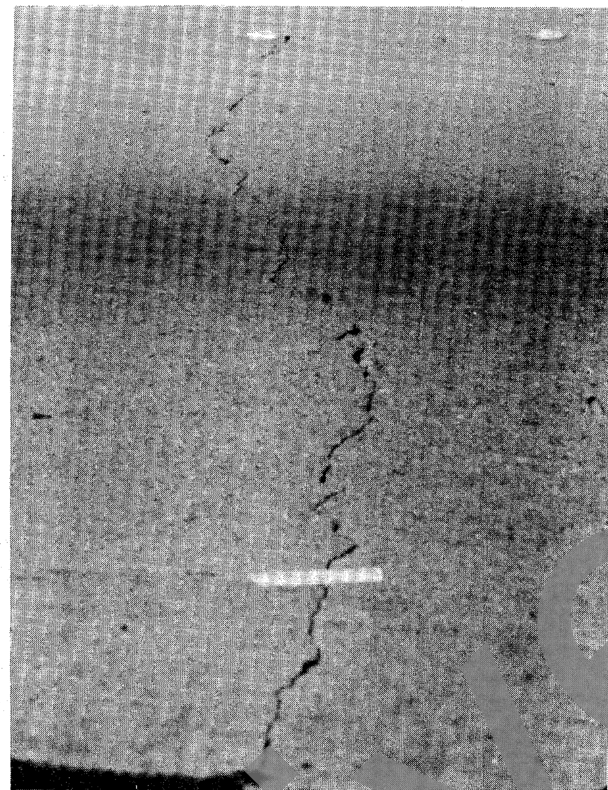

Figure 3.49. Low Approaching Medium Severity Transverse Crack.

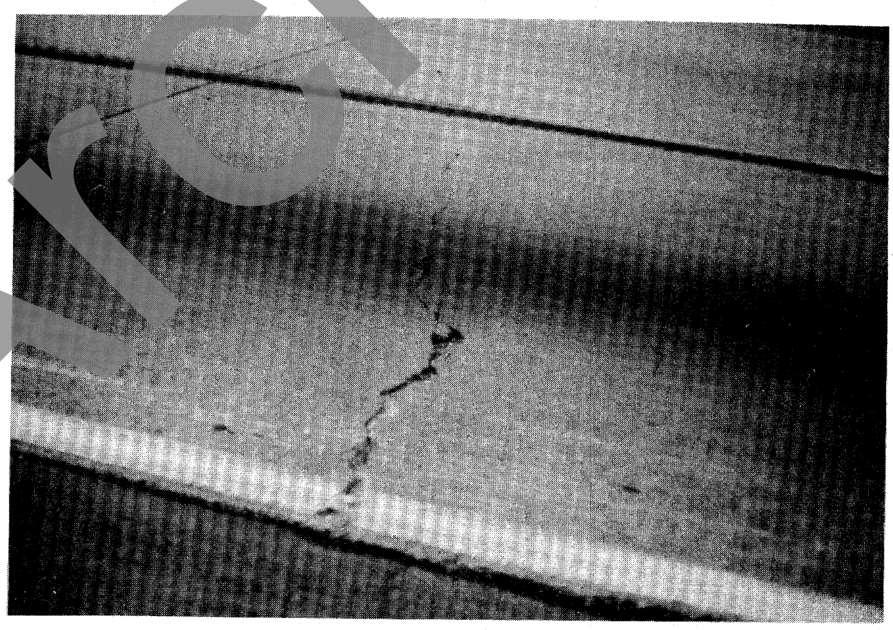

Figure 3.50. Medium Severity Transverse Crack.

Figure 3.51. Medium Severity Transverse Crack.

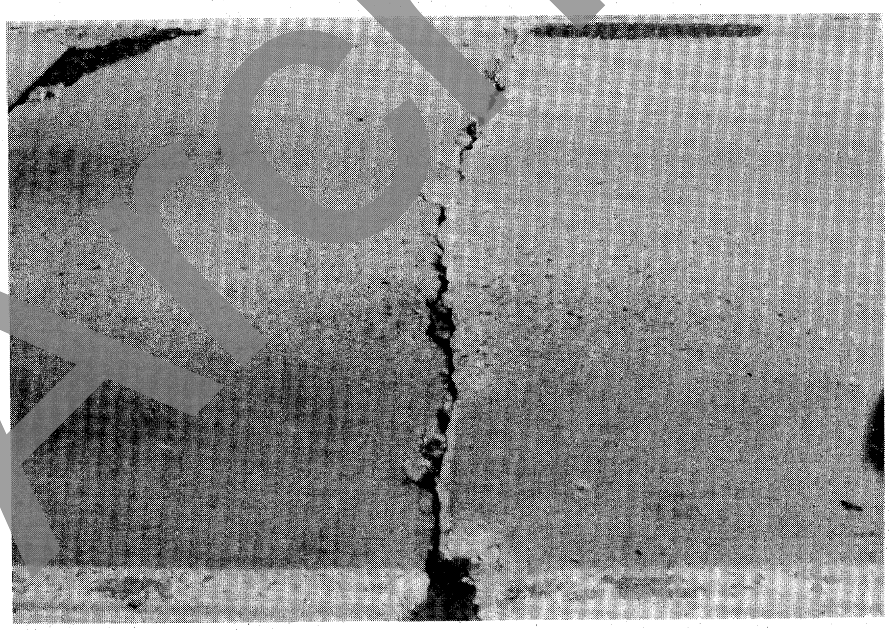

Figure 3.52. High Severity Transverse Crack.

JOINTED REINFORCED CONCRETE DISTRESS

Name of Distress: Blow-up

Description: Blow-ups occur in hot weather at a transverse joint or crack which will not permit expansion of the concrete slabs. The insufficient expansion width of joints is usually caused by infiltration of incompressible materials into the joint space. When compressive expansion pressure cannot be relieved, a localized upward movement of the slab edges (buckling) or shattering occurs in the vicinity of the joint. Blow-ups can also occur at utility cut patches and drainage inlets. Blow-ups are accelerated due to a spalling away of the slab at the bottom creating reduced joint contact area. The presence of "D" cracking also weakens the concrete near the joint resulting in increased spalling and blow-up potential.

Severity Levels:

L - Buckling or shattering has occurred, but only causes some bounce of the vehicle which creates no discomfort.

M - Buckling or shattering causes a significant bounce of the vehicle which creates some discomfort. Temporary patching has been placed because of a blow-up.

H - Buckling or shattering causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Blow-ups are measured by counting the number existing in each inspection unit. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

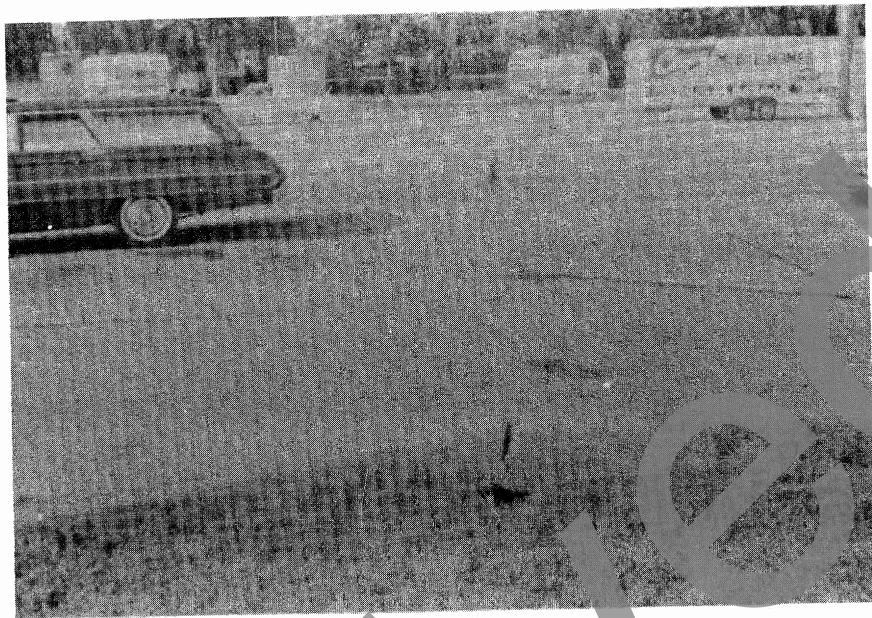

Figure 4.1. High Severity Buckling Type Blow-up.

Figure 4.2. High Severity Shattering Type Blow-up.

Name of Distress: Corner Break

Description: A corner break is a crack that intersects the joints at a distance less than 6 ft (1.8 m) on either side measured from the corner of the slab. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle. Load repetition combined with loss of support, poor load transfer across joint, and thermal curling and moisture warping stresses usually cause corner breaks.

Severity Levels:

L - Crack is tight (hairline). Well sealed cracks will be considered tight. No faulting or break-up at broken corner exists. Crack is not spalled.

M - Crack is working and spalled at low or medium severity. Break-up of broken corner has not occurred. Faulting of crack or joint must be less than 1/2 inch (13 mm). Temporary patching has been placed because of corner break.

H - Crack is spalled at high severity or the corner piece has broken into two or more pieces. If faulting of crack or joint is more than 1/2 inch (13 mm), it will be considered high severity.

How to Measure: Corner breaks are measured by counting the number that exists in each inspection unit. Different levels of severity should be counted and recorded separately. Corner breaks adjacent to a patch will be counted as patch adjacent slab deterioration.

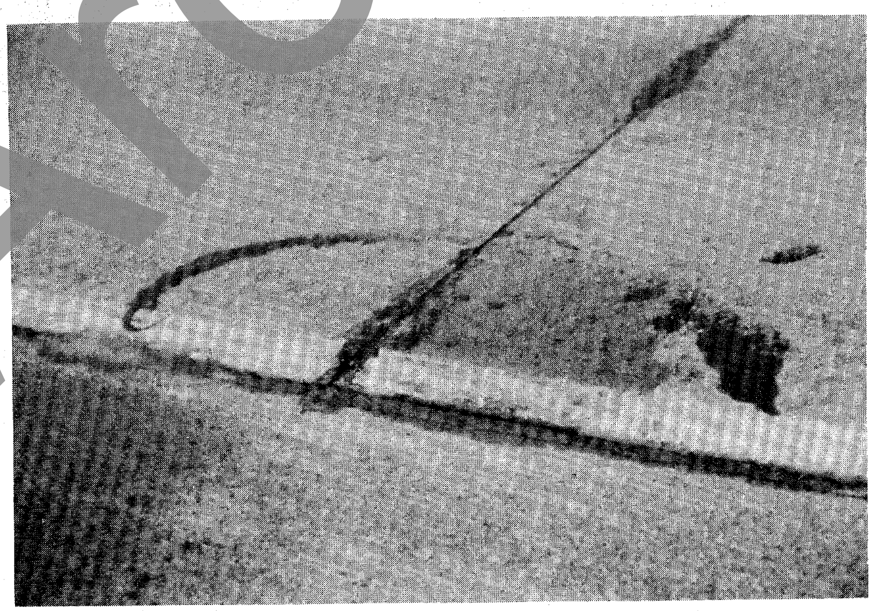

Figure 4.3. Low Severity Corner Break.

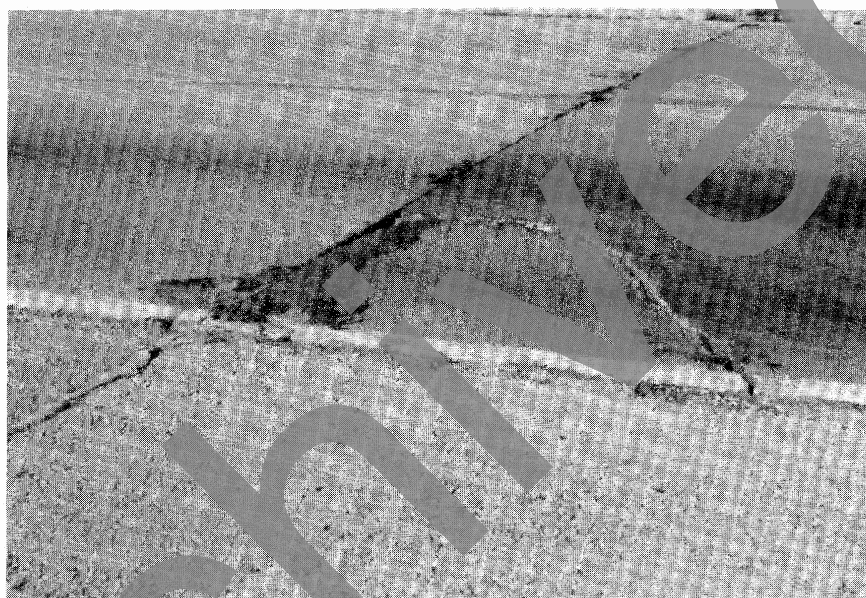

Figure 4.4. High Severity Corner Break.

Name of Distress: Depression

Description: Depressions in concrete pavements are surface areas having elevations lower than those of the surrounding pavement. There is generally significant slab cracking in these areas due to uneven settlement. In many instances, light depressions are not noticeable until after a rain when ponding water creates "bird-bath" areas. The depressions may also be located without rain by stains caused by oil droppings from vehicles. Depressions can be caused by settlement or consolidation of the foundation soil or can be "built in" during construction. They are frequently found above culverts. This is usually caused by poor compaction of soil around the culvert during construction. Depressions cause slab cracking, roughness, and hydroplaning when filled with water of sufficient depth.

Severity Levels:

L - Depression causes some bounce of the vehicle which creates no discomfort.

M - Depression causes significant bounce of the vehicle which creates some discomfort.

H - Depression causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Depressions are measured by counting the number that exists in each inspection unit. Each depression is rated according to its level of severity. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Name of Distress: Durability ("D") Cracking

Description: "D" cracking is a series of closely spaced crescent-shaped hairline cracks that appear at a PCC pavement slab surface adjacent and roughly parallel to transverse and longitudinal joints, transverse and longitudinal cracks, and the free edges of pavement slab. The fine surface cracks often curve around the intersection of longitudinal joints/cracks and transverse joints/cracks. These surface cracks often contain calcium hydroxide residue which causes a dark coloring of the crack and immediate surrounding area. This may eventually lead to disintegration of the concrete within 1-2 ft. (0.30-0.6 m) of more of the joint or crack, particularly in the wheelpaths. "D" cracking is caused by freeze-thaw expansive pressures of certain types of coarse aggregates. Concrete durability problems caused by reactive aggregates are rated under "Reactive Aggregate Distress."

Severity Levels:

L - The characteristic crack pattern of closely spaced fine cracks with calcium hydroxide residue appears near joints, cracks, and/or free edges; however, the width of the affected area is generally less than 12 in. wide at the center of the lane in transverse cracks and joints. The crack pattern may fan out at the intersection of transverse cracks/joints with longitudinal cracks/joints. No joint/crack spalling or only minor corner spalling is present.

M - The characteristic crack pattern of closely spaced cracks had developed near the crack, joint or free edge and is generally wider than 12 in. (30 cm) at the center of the lane in transverse cracks and/or joints. A low or medium severity level of joint/crack or corner spalling has developed in the affected area. Temporary patching has been placed due to "D" cracking induced spalling.

H - The affected joint or crack has a high severity level of spalling at joints/cracks or corners. Considerable material is loose in the affected area. The crack pattern has developed generally over the entire slab area between cracks and/or joints.

How to Measure: "D" cracking is measured by counting the number of joints or cracks (including longitudinal) affected. Different severity levels will be counted and recorded separately. "D" cracking adjacent to a patch will be rated as patch-adjacent slab deterioration. "D" cracking should not be counted if the fine crack pattern has not developed near cracks, joints and free edges. Popouts and discoloration of joints, cracks and free edges may occur without "D" cracking.

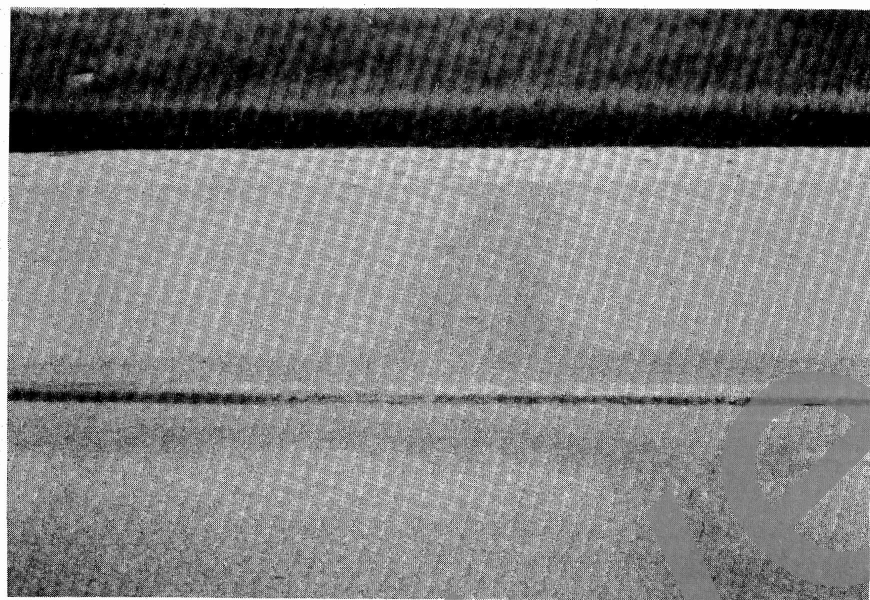

Figure 4.5. Low Severity "D" Cracking.

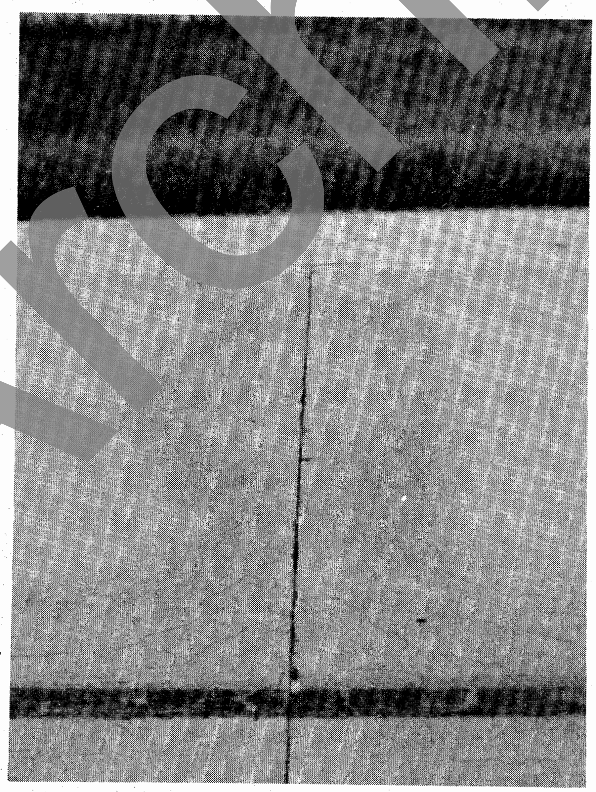

Figure 4.6. Medium Severity "D" Cracking.

Figure 4.7. Medium Severity "D" Cracking.

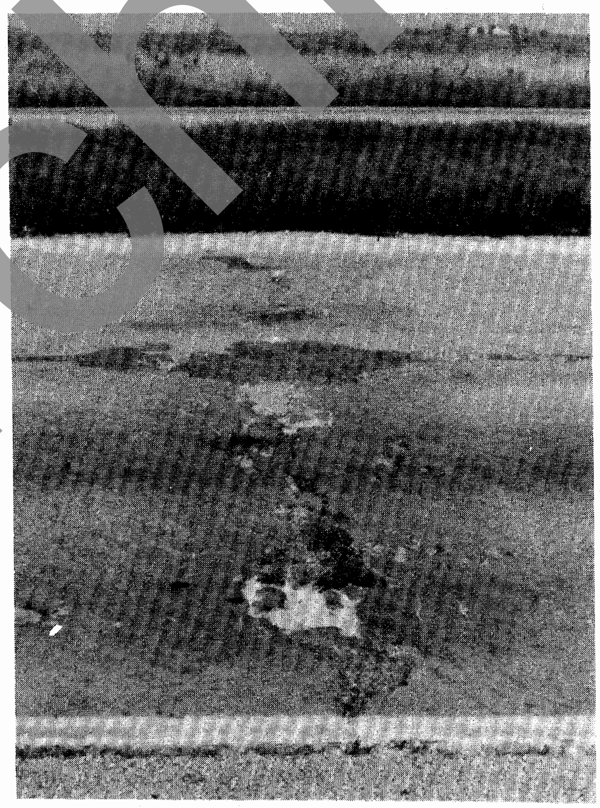

Figure 4.8. High Severity "D" Cracking.

Figure 4.9. High Severity "D" Cracking.

Name of Distress: Faulting of Transverse Joints and Cracks

Description: Faulting is the difference of elevation across a joint or crack. Faulting is caused in part by a buildup of loose materials under the approach slab near the joint or crack as well as depression of the leave slab. The buildup of eroded or infiltrated materials is caused by pumping (free moisture under pressure) due to heavy loadings. The warp and/or curl upward of the slab near the joint or crack due to moisture and/or temperature gradient contributes to the pumping condition. Lack of load transfer contributes greatly to faulting.

Severity Levels:

L - Average faulting is equal to or less than 1/16 inch (1.5 mm).

M - Average faulting is more than 1/16 inch (1.5 mm) but less than 1/5 inch (5 mm).

H - Average faulting is equal to or more than 1/5 inch (5 mm).

How to Measure: Faulting is determined by measuring the difference in elevation of slabs at joints for the slabs in the sample unit. Faulting of cracks will be measured and recorded separately. Faulting will be measured one foot in from the outside (right) slab edge on all lanes except the inner passing lane. Faulting will be measured one foot in from the inside (left) slab edge on the inner passing lane.

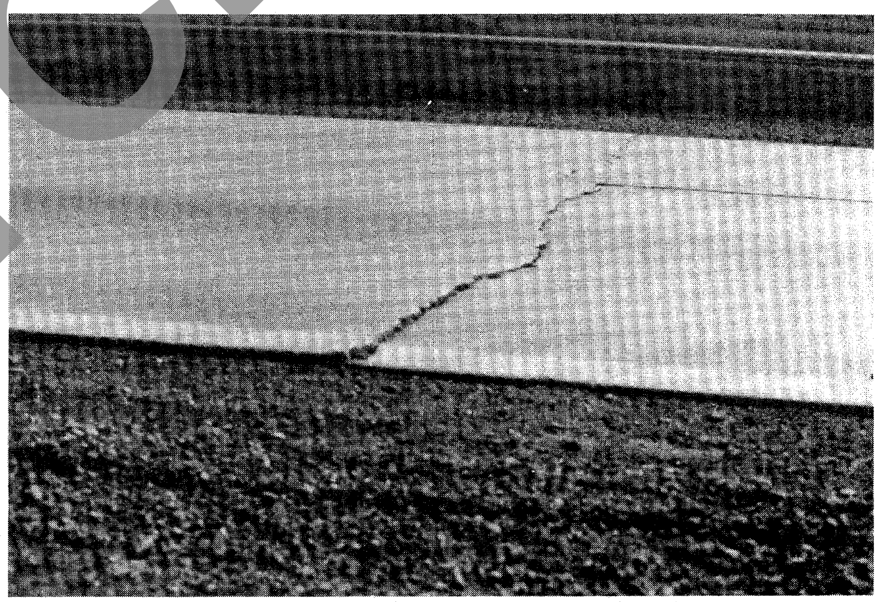

Figure 4.10. Crack Faulting.

Figure 4.11. Joint Faulting.

Name of Distress: Joint Load Transfer System Associated Deterioration (Second Stage Cracking)

Description: This distress develops as a transverse crack a short distance from a transverse joint, usually at the end of joint load transfer dowels. This usually occurs when the dowel system fails to function properly due to extensive corrosion or misalignment. It may also be caused by a combination of small diameter dowels and heavy traffic loadings.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - The crack has opened to a width less than 1 inch (25 mm); the crack has faulted less than 1/2 inch (13 mm); the crack may have spalled to a low or medium severity level; or the area between the crack and joint has started to break up but pieces have not been dislodged to the point that a tire damage or safety hazard is present. Temporary patches have been placed due to this joint deterioration.

H - A crack with width of opening greater than 1 inch (25 mm); a crack with a high severity level of spalling; a crack faulted 1/2 inch (13 mm) or more; or, the area between the crack and joint has broken up and pieces have been dislodged to the point that a tire damage or safety hazard is present.

How to Measure: The number of joints with each severity level are counted in each inspection unit.

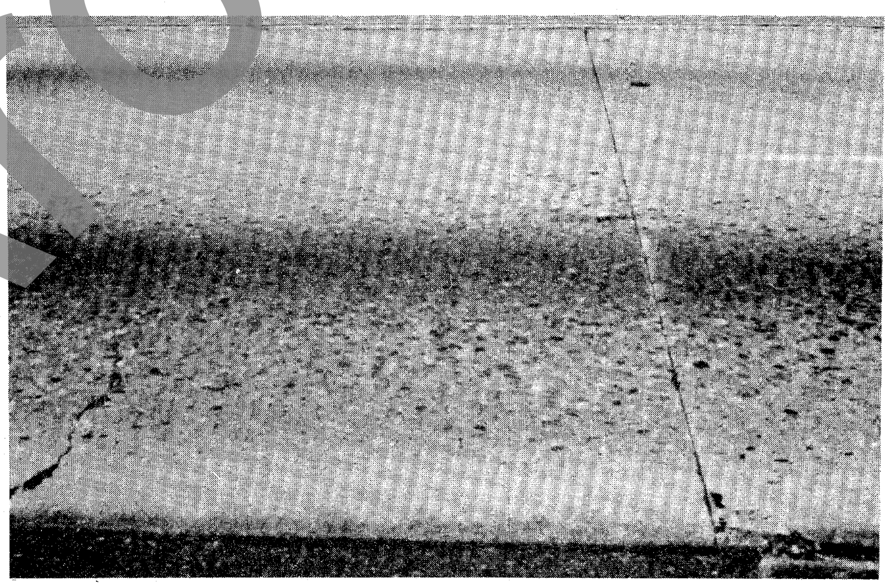

Figure 4.12. Low Severity Joint Load Transfer System Associated Deterioration in Traffic Lane at Top of Photo.

Figure 4.13. Medium Severity Joint Load Transfer System Associated Deterioration.

Figure 4.14. High Severity Joint Load Transfer System Associated Deterioration.

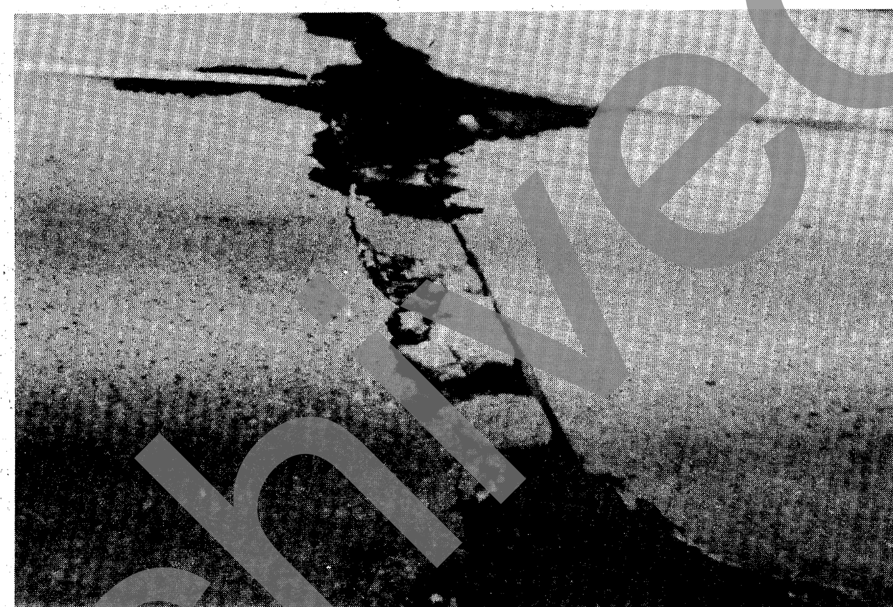

Figure 4.15. High Severity Joint Load Transfer System Associated Deterioration (transverse crack occurs at end of dowel bars).

Name of Distress: Joint Seal Damage of Transverse Joints

Description: Joint seal damage is any condition which enables incompressible materials to infiltrate into the joints from the surface or allows significant infiltration of water. Accumulation of incompressible materials within the joints restricts in-slab expansion and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protect the joints from accumulation of incompressible materials, and also reduces the amount of water seeping into the pavement structure. Typical types of joint seal damage are: (1) stripping of joint sealant, (2) extrusion of joint sealant, (3) weed growth, (4) hardening of the filler (oxidation), (5) loss of bond to the slab edges, and (6) lack or absence of sealant in the joint.

Severity Levels:

L - Joint sealer is in generally good condition throughout the section. Sealant is performing well with only a minor amount of any of the above types of damage present. Little water and no incompressibles can infiltrate through the joint.

M - Joint sealer is in generally fair condition over the entire surveyed section, with one or more of the above types of damage occurring to a moderate degree. Water can infiltrate the joint fairly easily; some incompressibles can infiltrate the joint. Sealant needs replacement within 3 years.

H - Joint sealer is in generally poor condition over the entire surveyed section, with one or more of the above types of damage occurring to a severe degree. Water and incompressibles can freely infiltrate the joint. Sealant needs immediate replacement.

How to Measure: Joint seal damage of transverse joints is rated based on the overall condition of the sealant over the entire inspection unit.

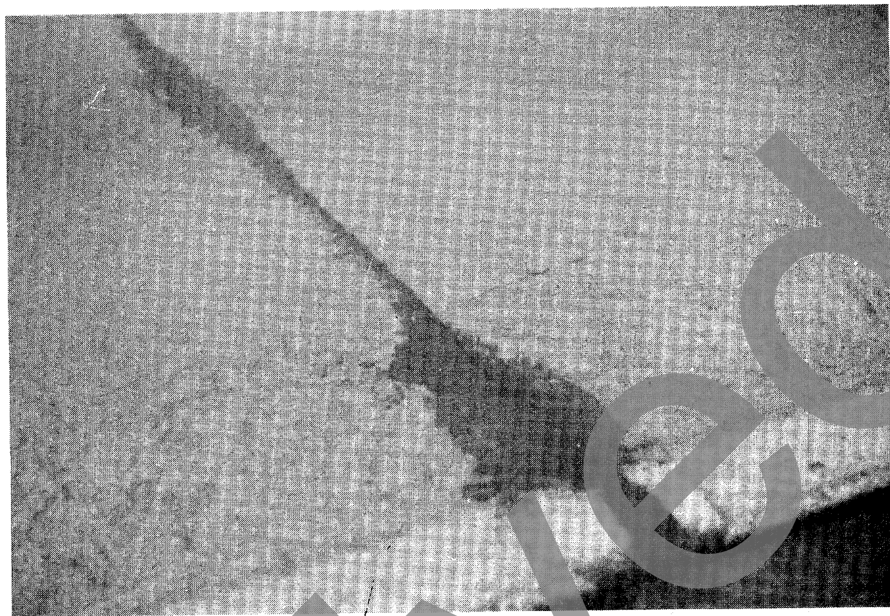

Figure 4.16. Low Severity Joint Seal Damage.

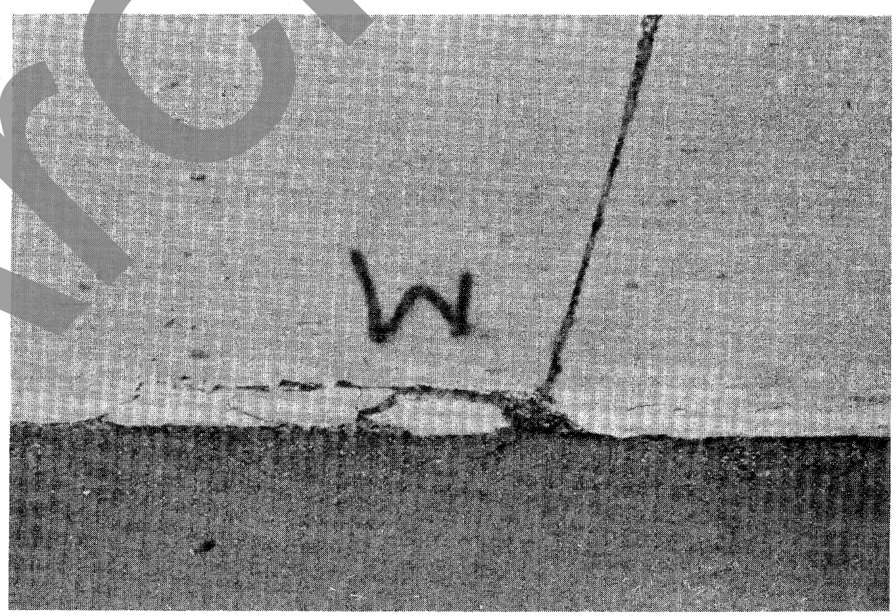

Figure 4.17. Medium Severity Joint Seal Damage.

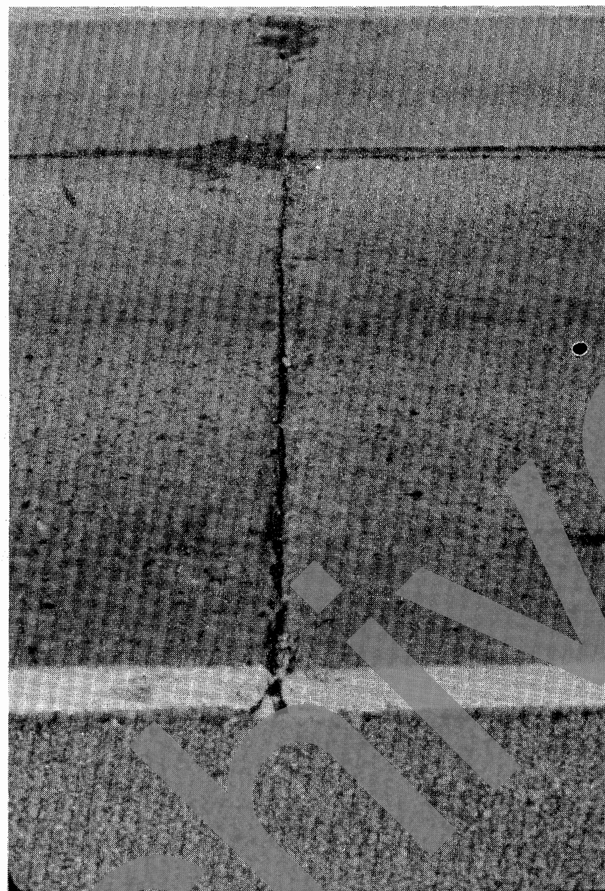

Figure 4.18. High Severity Joint Seal Damage.

Name of Distress: Lane/Shoulder Dropoff or Heave

Description: Lane/Shoulder dropoff or heave occurs wherever there is a difference in elevation between the traffic lane and shoulder. Typically the outside shoulder settles due to consolidation or a settlement of the underlying granular or subgrade material, or pumping of the underlying material. Heave of the shoulder may occur due to frost action or swelling soils. Dropoff of granular or soil shoulder is generally caused from blowing away of shoulder material from passing trucks.

Severity Level: Severity level is determined by computing the mean difference in elevation between the traffic lane and shoulder:

L	1/4 - 1/2 in.	(6 - 13 mm)
M	1/2 - 1 in.	(3 - 25 mm)
H	> 1 in.	(> 25 mm)

How to Measure: Lane/shoulder dropoff or heave is measured every 100 ft. (30 m) in inches (or mm) along the joint. The mean difference in elevation is computed from the data and used to determine severity level.

Figure 4.19. Lane/Shoulder Dropoff.

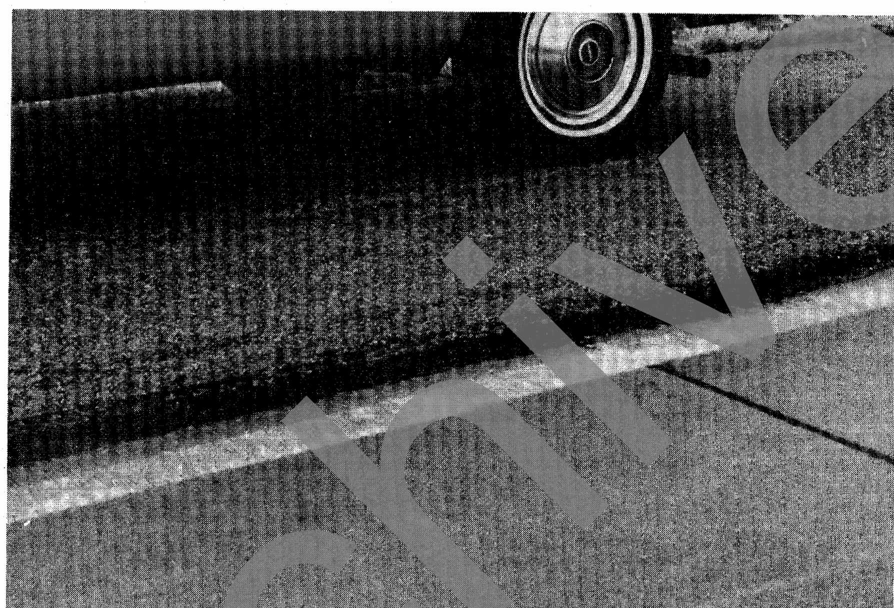

Figure 4.20. Lane/Shoulder Heave.

Name of Distress: Lane/Shoulder Joint Separation

Description: Lane/shoulder joint separation is the widening of the joint between the traffic lane and the shoulder generally due to movement in the shoulder. If the joint is tightly closed or well sealed so that water cannot easily infiltrate, then lane/shoulder joint separation is not considered a distress.

Severity Level: No severity level is counted if the joint is tightly sealed.

L - Some opening but less than or equal to 0.12 inch (3 mm).

M - More than 0.12 inch (3 mm) but equal to or less than 0.4 inch (10 mm) opening.

H - More than 0.4 inch (10 mm) opening.

How to Measure: Lane/shoulder joint separation is measured and recorded in inches (or mm) near transverse joints and at mid slab. The mean separation is used to determine the severity level.

Figure 4.21. Lane/Shoulder Separation (Asphalt Shoulder).

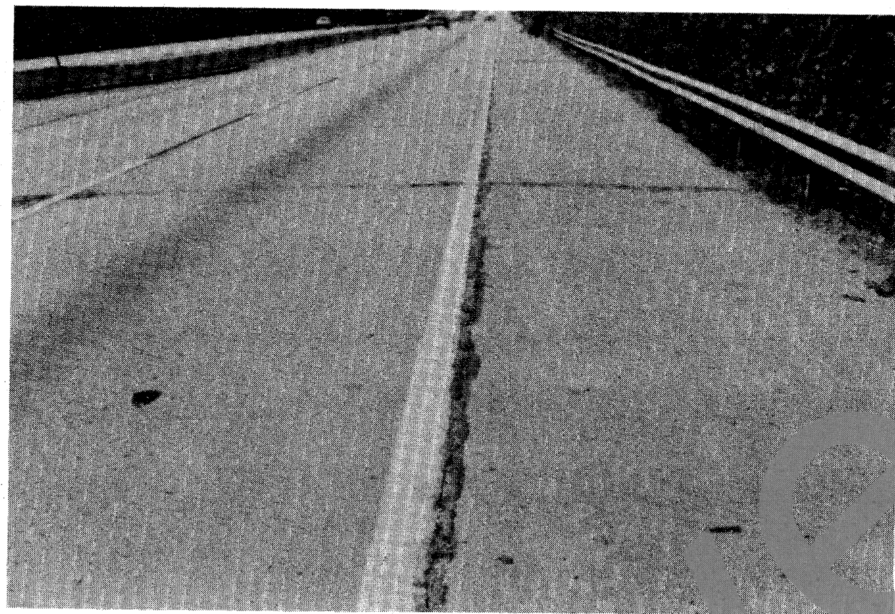

Figure 4.22. Lane/Shoulder Separation (PCC Shoulder).

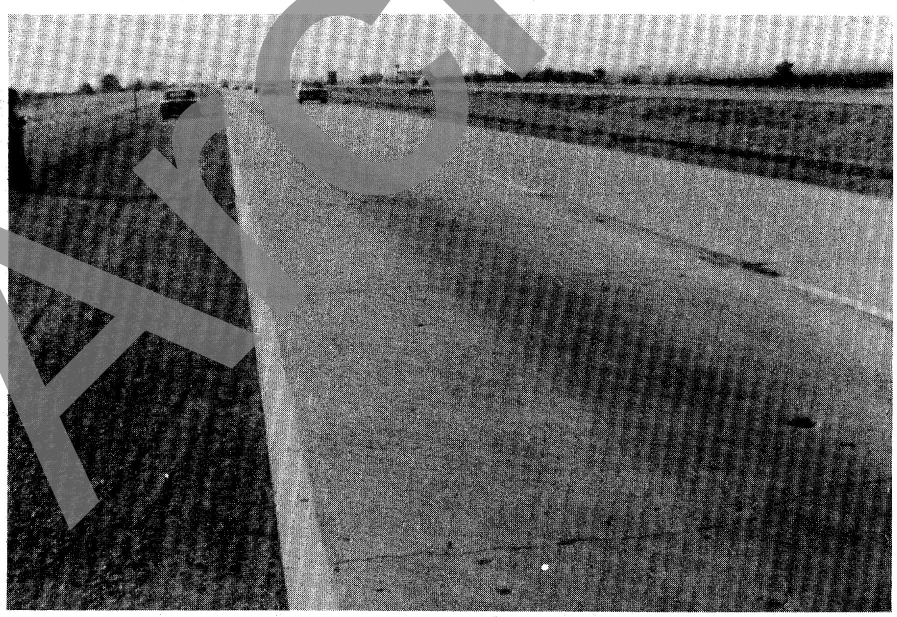

Figure 4.23. Lane/Shoulder Separation (high severity due to gravel shoulder).

Name of Distress: Longitudinal Cracks

Description: Longitudinal cracks occur generally parallel to the centerline of the pavement. They are often caused by improper construction of longitudinal joints, or by a combination of heavy load repetition, loss of foundation support, and thermal and moisture gradient stresses.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - Working crack with a moderate or less severity level of spalling and/or faulting less than 1/2 inch (13 mm).

H - A crack with width greater than 1 inch (25 mm); a crack with a high severity level of spalling; or, a crack faulted 1/2 inch (13 mm) or more.

How to Measure: Cracks are measured in linear feet or meters for each level of distress. The length and severity of each crack should be identified and recorded. If the crack does not have the same severity level along the entire length, each general portion of the crack having a different severity level should be recorded separately.

Figure 4.24. Low Severity Longitudinal Crack.

Figure 4.25. High Severity Longitudinal Crack in Center Lane.

Name of Distress: Longitudinal Joint Faulting

Description: Longitudinal joint faulting is a difference in elevation at the longitudinal joint between two traffic lanes.

Severity Levels:

L - Some faulting but less than 1/4 inch (6 mm).

M - Faulting of 1/4 inch (6 mm) to 1/2 inch (13 mm).

H - Faulting of 1/2 inch (13 mm) or more

How to Measure: Where the longitudinal joint has faulted, the length of the affected area and the maximum joint faulting will be recorded.

Figure 4.26. Longitudinal Joint Faulting.

Name of Distress: Patch Deterioration

Description: A patch is an area where the original pavement has been removed and replaced by either similar or different material (i.e., concrete or asphalt). Only permanent patches should be considered.

Severity Levels:

L - Patch is functioning well with little or no deterioration. Some low severity spalling of the patch edges may exist. Faulting across the slab-patch joint must be less than 1/4 inch (6 mm). Patch is rated low severity even if it is in excellent condition.

M - Patch has cracked (low severity level) and/or some spalling of medium severity level exists around the edges. Minor rutting may be present. Faulting at 1/4 to 3/4 inch (6-19 mm) exists. Temporary patches have been placed because of permanent patch deterioration.

H - Patch has deteriorated, either by spalling of the patch rutting or cracking within the patch, to a condition which requires replacement.

How to Measure: The number of patches within each sample unit is recorded. Patches at different severity levels are counted and recorded separately. Additionally, the approximate square footage (or meters) of each patch and type (i.e., PCC or asphalt) is recorded. Location of the patch should be identified (joint or slab). All patches are rated either L, M, or H.

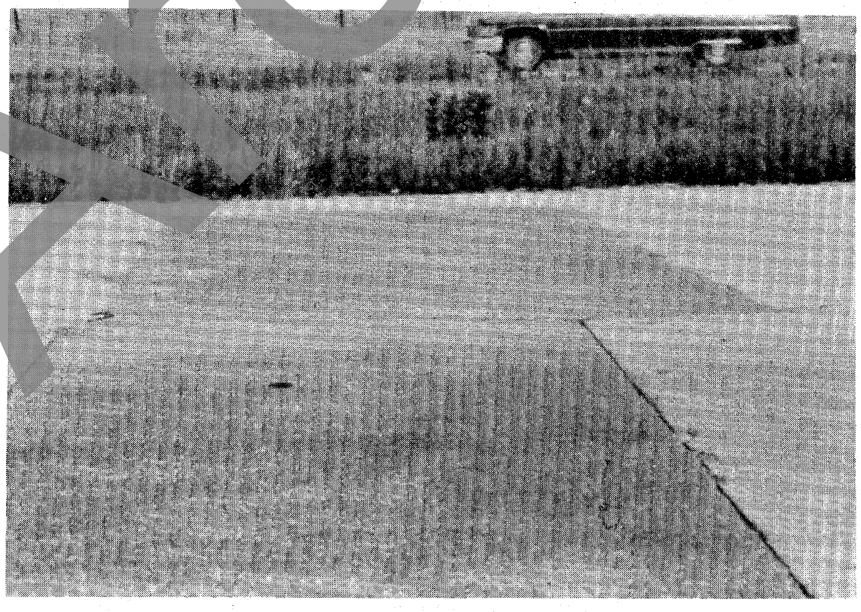

Figure 4.27. Low Severity Asphalt Patch Deterioration.

Figure 4.28. High Severity Asphalt Patch Deterioration.

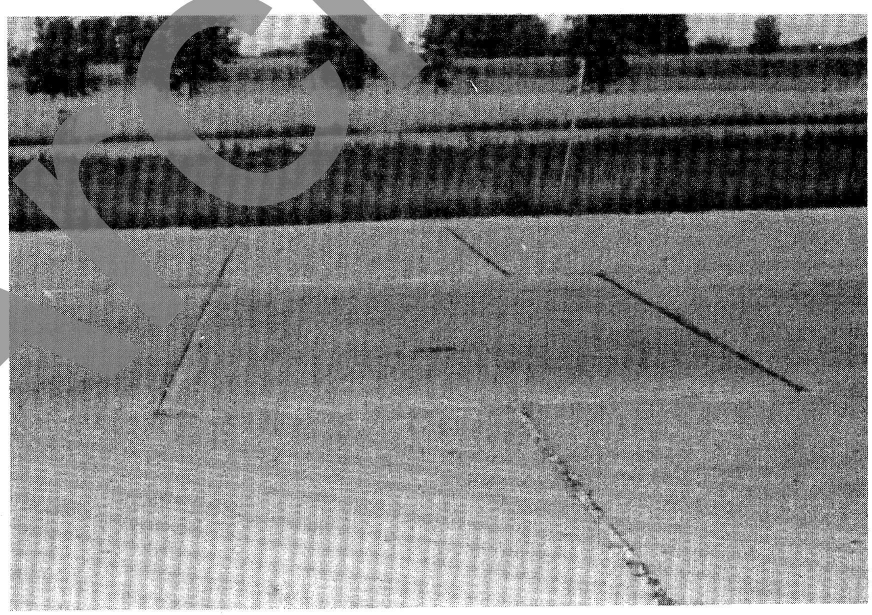

Figure 4.29. Low Severity Concrete Patch Deterioration.

Figure 4.30 Medium Severity Concrete Patch Deterioration.

Figure 4.31. High Severity Concrete Patch Deterioration.

Name of Distress: Patch Adjacent Slab Deterioration

Description: Deterioration of the original concrete slab adjacent to a permanent patch is given the above name. This may be in the form of spalling of the slab at the slab/patch joint, "D" cracking of the slab adjacent to the patch, a corner break in the adjacent slab, or a second permanent patch placed adjacent to the original patch.

Severity Levels: Severity levels are the same as that described for the particular distress found. A second permanent patch placed adjacent to a previously placed permanent patch will be rated as medium severity. Temporary patches placed because of this deterioration will also be rated as medium severity.

How to Measure: The number of permanent patches with distress in the original slab adjacent to the patch at each severity level will be counted and recorded separately. Additionally, the type of patch (AC or PCC) and distress will be recorded separately, along with the location (joint or slab).

Figure 4.32. Patch Adjacent Slab Deterioration (Corner Break).

Figure 4.33. Patch Adjacent Slab Deterioration ("D" cracking & temporary patching).

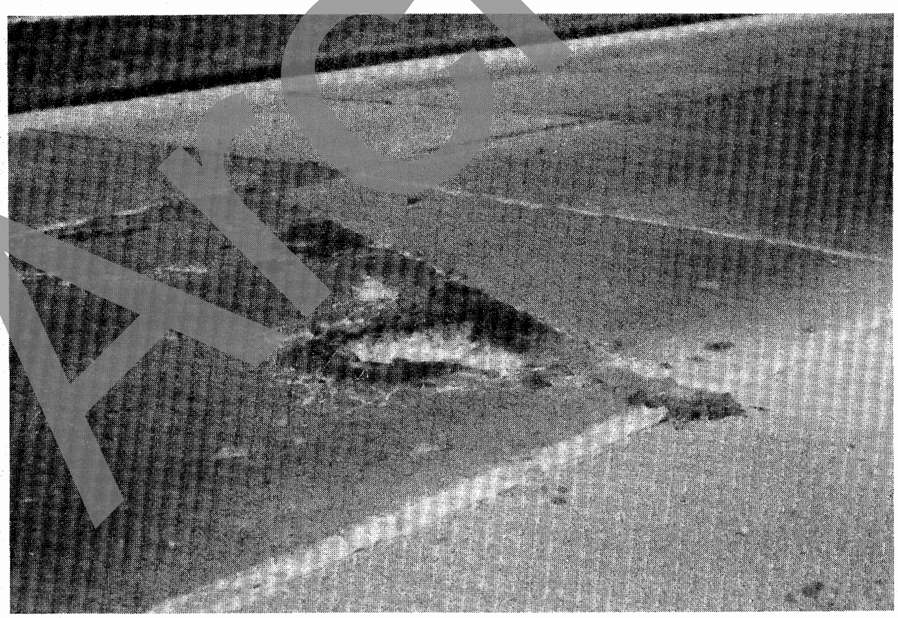

Figure 4.34. Patch Adjacent Slab Deterioration (second patch, spalling, "D" cracking and temporary patching).

Name of Distress: Popouts

Description: A popout is a small piece of concrete that breaks loose from the pavement surface due to freeze-thaw action, expansive aggregates, or nondurable aggregates. The occurrence of extensive popouts may be indicative of unsound aggregates and "D" cracking. Popouts usually range from approximately 1 inch (25 mm) to 4 inch (10 cm) in diameter and from 1/2 inch to 2 inch (13-51 mm) deep.

Severity Levels: No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; i.e., average popout density must exceed approximately one popout per square yard (square meter) over the entire slab area.

How to Measure: The density of popouts can be determined by counting the number of popouts per square yard of surface in areas having typical amounts.

Figure 4.35. Popouts.

Name of Distress: Pumping and Water Bleeding

Description: Pumping is the ejection of material by water through joints or cracks, caused by deflection of the slab under moving loads. As the water is ejected, it carries particles of gravel, sand clay, or silt, resulting in a progressive loss of pavement support. Surface staining or accumulation of base or subgrade material on the pavement surface close to joints or cracks is evidence of pumping. Pumping can occur without such evidence, particularly when stabilized bases are used. The observation of water being ejected by heavy traffic loads after a rain storm can also be used to identify pumping. Water bleeding occurs when water seeps out of joints or cracks.

Severity Levels:

L - Water is forced our of a joint or crack when trucks pass over the joints or cracks, water is forced out of the lane/shoulder joint when trucks pass along the joint, or water bleeding exists. No fines can be seen on the surface of the traffic lanes or shoulder.

M - A small amount of pumped material can be observed near some of the joints or cracks on the surface of the traffic lane or shoulder.

H - A significant amount of pumped materials exist on the pavement surface of the traffic lane or shoulder along the joints or cracks.

How to Measure: If pumping or water bleeding exists anywhere in the sample unit it is counted as occurring at highest severity level noted.

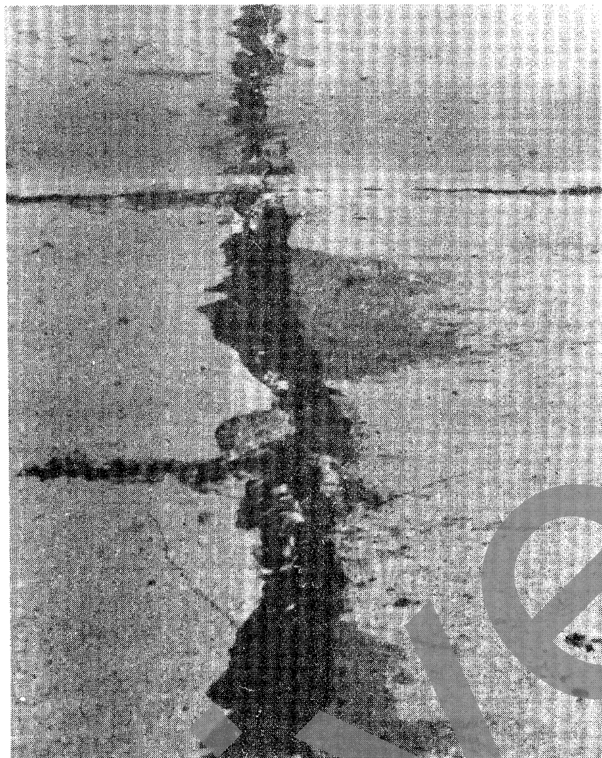

Figure 4.36. Low Severity Pumping (Water Bleeding).

Figure 4.37. Medium Severity Pumping (pumped material like this occurs only at a few of the joints and cracks).

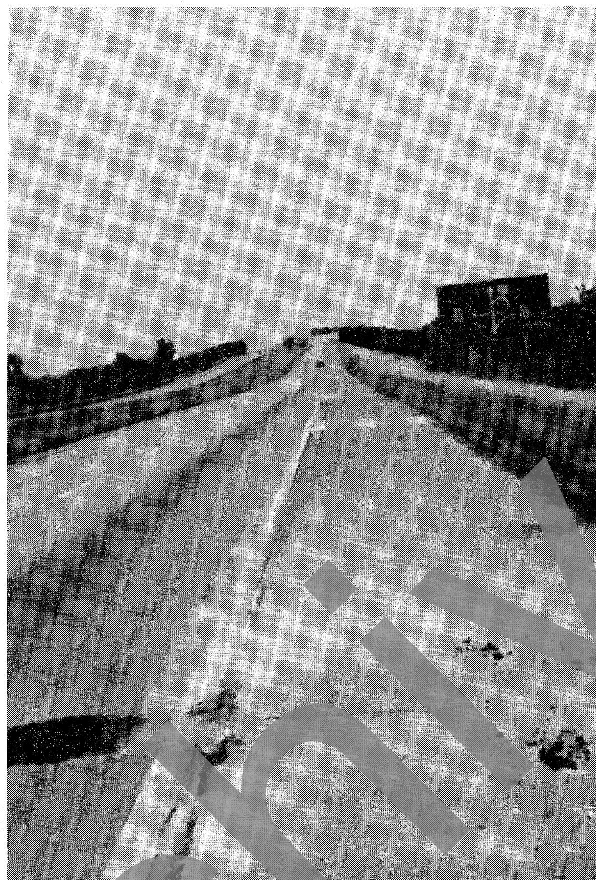

Figure 4.38. High Severity Pumping.

Name of Distress:	Reactive Aggregate Distress
Description:	Reactive aggregates either expand in alkaline environments or develop prominent siliceous reaction rims in concrete. It may be an alkali-silica reaction or an alkali-carbonate reaction. As expansion occurs, the cement matrix is disrupted and cracks. It appears as a map cracked area; however, the cracks may go deeper into the concrete than in normal map cracking. It may affect most of the slab or it may first appear at joints and cracks.
Severity Levels:	Only one level of severity is defined. If alkali-aggregate cracking occurs anywhere in the slab, it is counted. If the reaction has caused spalling or map cracking, these also are counted.
How to Measure:	Reactive-aggregate distress is measured in square feet or square meters.

Figure 4.39. Reactive Aggregate Distress (Photo For Jointed Plain Concrete Pavement).

Name of Distress: Scaling, Map Cracking, and Crazing

Description: Map cracking or crazing refers to a network of shallow, fine, or hairline cracks which extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Map cracking or crazing is usually caused by over-finishing the concrete, and may lead to scaling of the surface, which is the breakdown of the slab surface to a depth of approximately 1/4 in. (6 mm) to 1/2 in. (13 mm). Scaling may be caused by deicing salts, traffic, improper construction, freeze-thaw cycles, and steel reinforcement too close to the surface.

Severity Levels:

L - Crazing or map cracking exists over most of the slab area; the surface is in good condition with no scaling. (Note: the low severity level is an indicator that scaling may develop in the future).

M - Less than 10% of any slab exhibits scaling.

H - More than 10% of any slab exhibits scaling.

How to Measure: Scaling, map cracking, and crazing are measured by recording % of area affected by each type severity level.

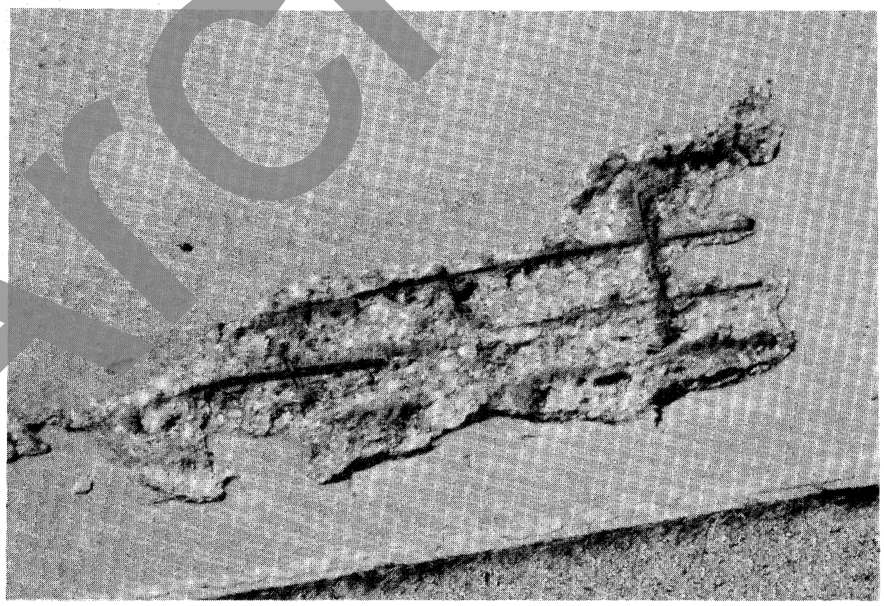

Figure 4.40. Scaling.

Figure 4.41. Scaling.

Name of Distress: Spalling (Transverse and Longitudinal Joint/Crack)

Description: Spalling of cracks and joints is the cracking, breaking or chipping of the slab edges within 2 ft. (0.6 m) of the joint. A joint spall usually does not extend vertically through the whole slab thickness, but extends to intersect the joint at an angle. Spalling usually results from (1) excessive stresses at the joint or crack caused by infiltration of incompressible materials and subsequent expansion or traffic loading, (2) disintegration of the concrete, (3) weak concrete at the joint (caused by over-working) combined with traffic loads, or (4) poorly designed or constructed load transfer device.

Severity Levels:

L - A spall less than two feet long; if spall is broken into pieces and fragmented, it must not extend more than three inches from the joint or crack. A spall more than two feet long with spall held tightly in place; if spall is cracked, it cannot be broken into more than three pieces. The joint is lightly frayed with fray extending no more than three inches from the edge of the joint or crack.

M - A spall is broken into pieces or fragmented and spall extends more than three inches from joint or crack. Some pieces may be loose and/or missing but the spalled area does not present a tire damage or safety hazard. The joint or crack is moderately frayed with fray extending more than three inches from the edge of the joint or crack but not causing a tire damage or safety hazard. Temporary patching has been placed because of spalling.

H - The joint is severely spalled or frayed to the extent that a tire damage or safety hazard exists.

How to Measure: Spalling is measured by counting and recording separately the number of joints with each severity level. If more than one level of severity exists along a joint, it will be recorded as containing the highest severity level present. Although the definition and severity levels are the same, spalling of cracks should not be recorded separately. The spalling of cracks is included in rating severity levels of cracks. Spalling of transverse and longitudinal joints will be recorded separately. Spalling of the slab edge adjacent to a permanent patch will be recorded as patch adjacent slab deterioration.

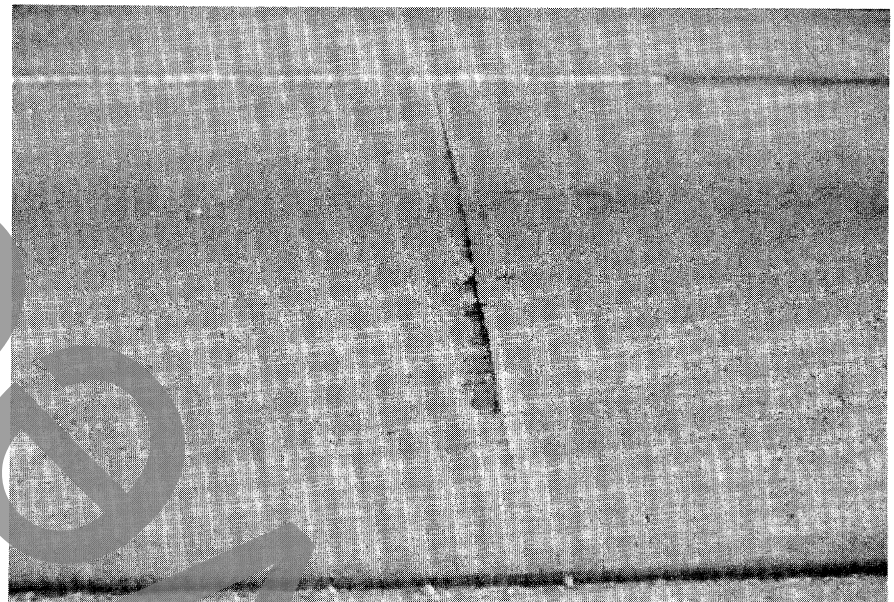

Figure 4.42. Low Severity Spalling (Fray).

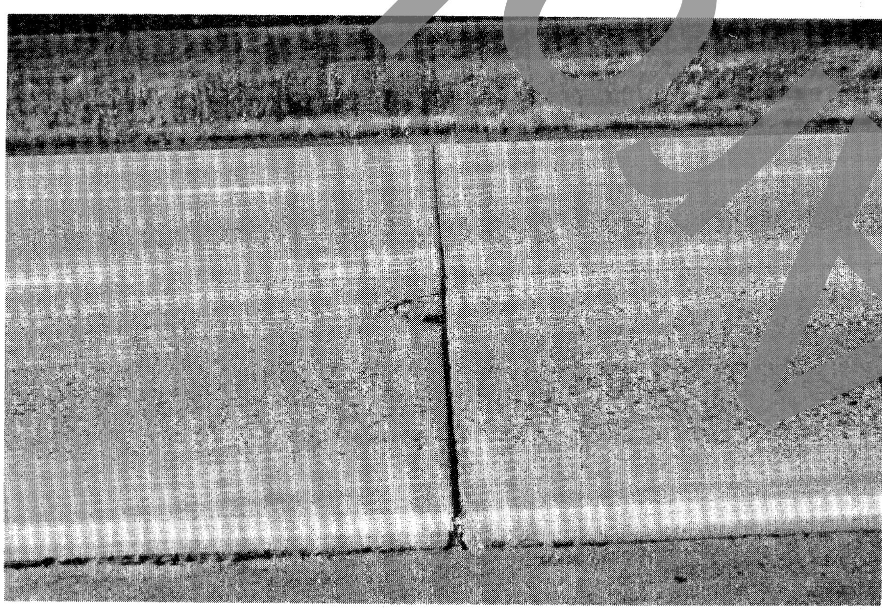

Figure 4.43. Low Severity Spalling.

Figure 4.44. Medium Severity Spalling In Passing Lane At Top Of photo And High Severity Spalling In Truck Lane.

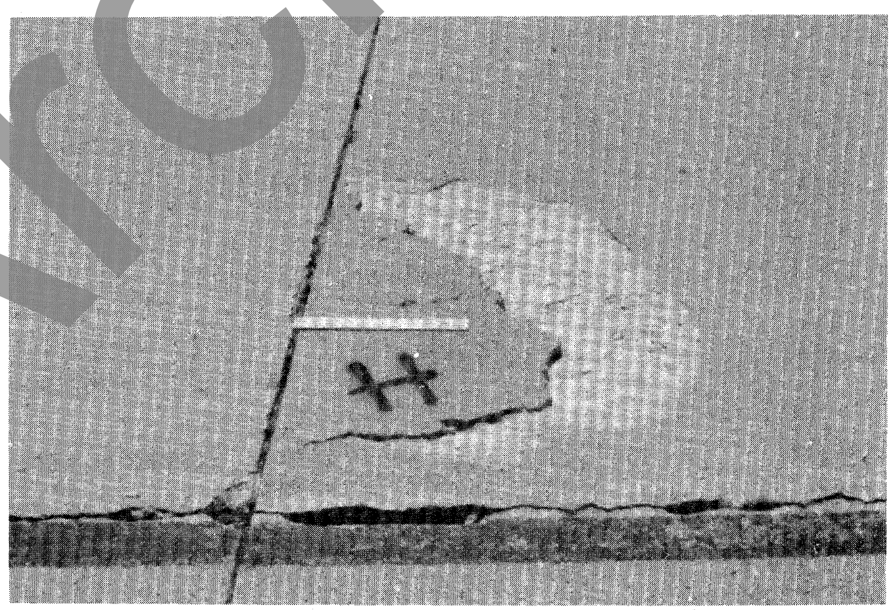

Figure 4.45. Medium Severity Spalling.

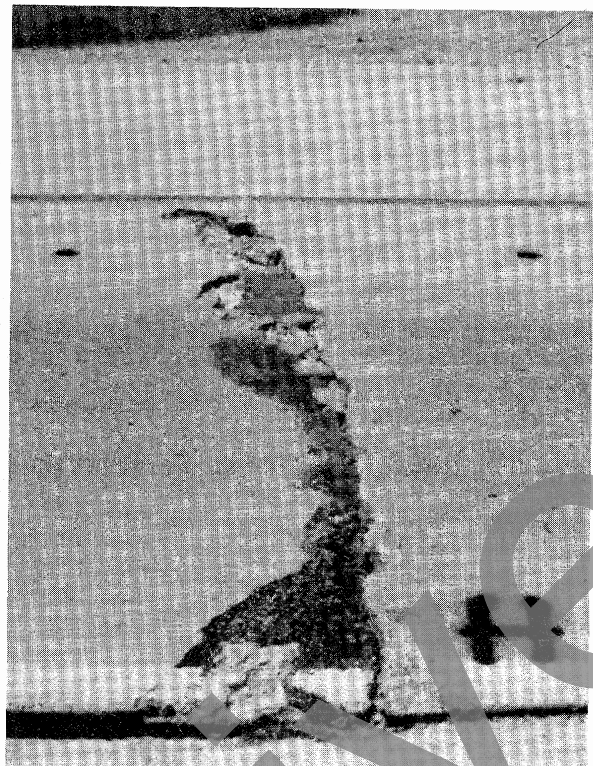

Figure 4.46. High Severity Spalling.

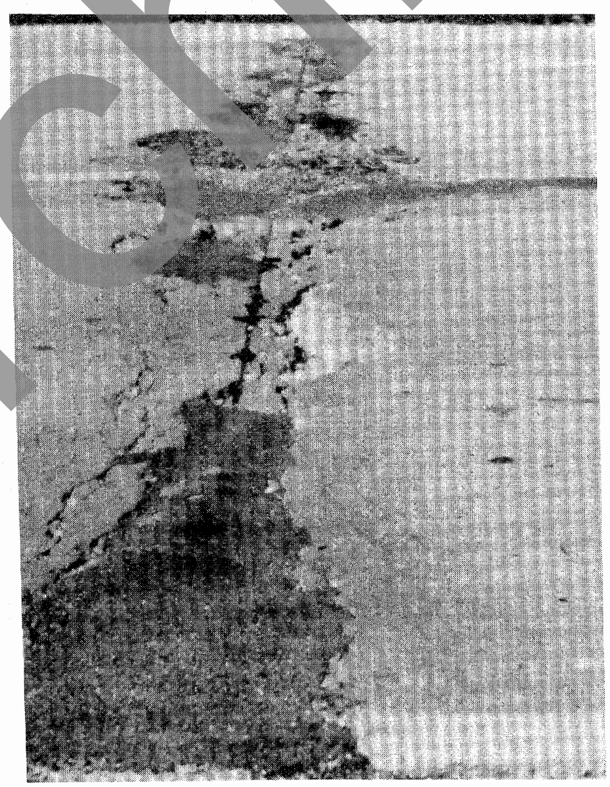

Figure 4.47. High Severity Spalling.

Name of Distress: Spalling (Corner)

Description: Corner spalling is the ravelling or breakdown of the slab within approximately 2 ft (0.6 m) of the corner. A corner spall differs from a corner break in that the spall usually angles downward at about 45° to intersect the joint, while a break extends vertically through the slab. Corner spalling can be caused by freeze-thaw, "D" cracking, and other factors.

Severity Level:

L - Spall is not broken into pieces. No spalling of cracks exists. Spall is in place and is not loose. Corner spalls with both edges less than 3 inches long will not be counted.

M - One of the following conditions exists: Spall is broken into pieces; cracks are spalled; some or all pieces are loose or absent but do not present tire damage or safety hazard. Corner spall is patched.

H - Spall is broken into and/or pieces of the spall have displaced to the extent that they present a tire damage or safety hazard.

How to Measure: Corner spalling is measured by counting and recording separately the number of corners spalled at each severity level within the inspection unit.

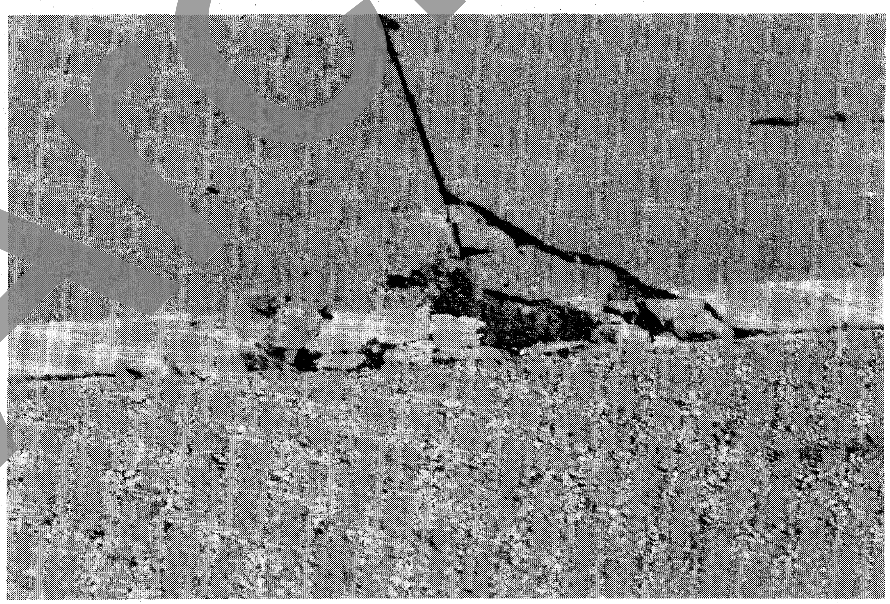

Figure 4.48. Medium Severity Corner Spall.

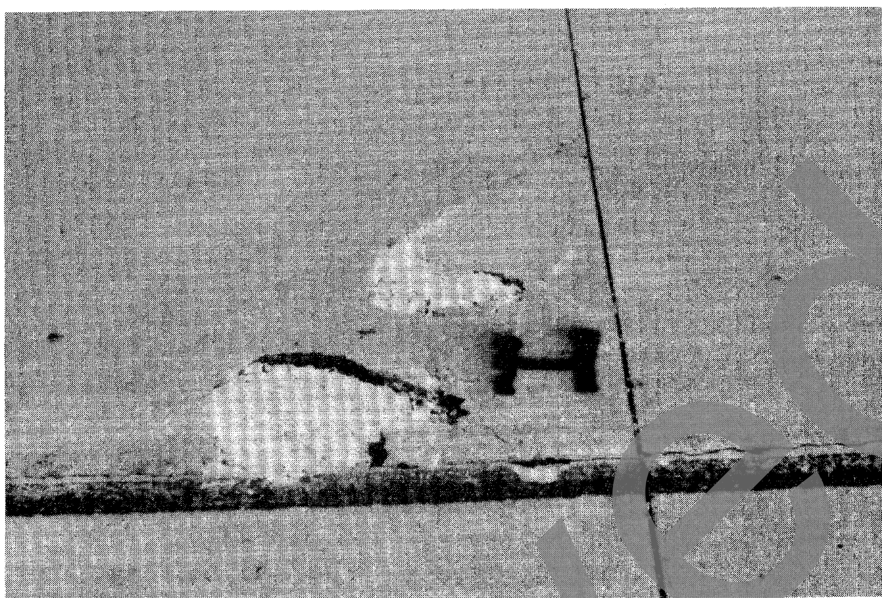

Figure 4.49. High Severity Corner Spall.

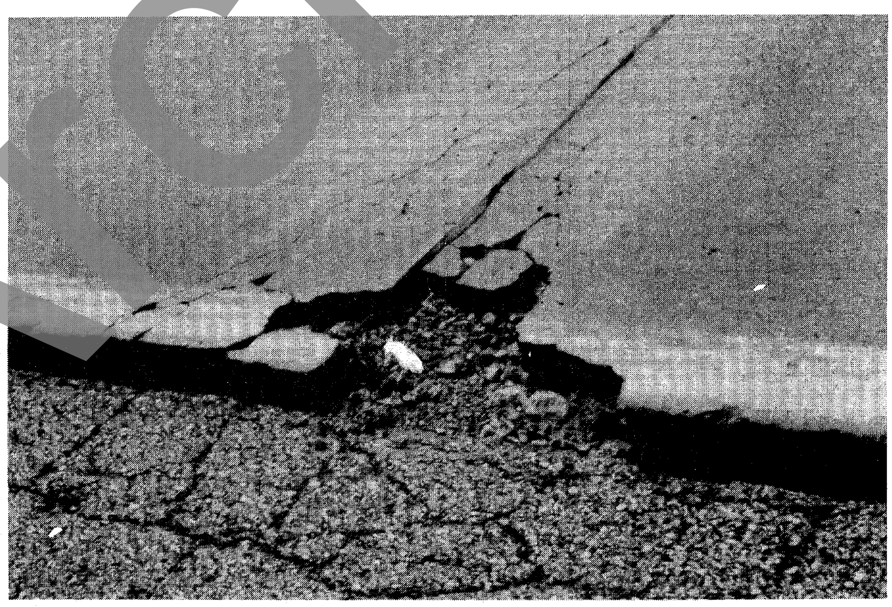

Figure 4.50. High Severity Corner Spall.

Name of Distress: Swell

Description: Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell is usually accompanied by slab cracking. A swell is usually caused by frost action in the subgrade or by swelling soil. Swells can often be identified by soil droppings on the surface.

Severity Levels:

L - Swell causes some bounce of the vehicle which creates no discomfort.

M - Swell causes significant bounce of the vehicle which creates some discomfort.

H - Swell causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: The number of swells within the inspection unit are counted and recorded by severity level. Severity levels are determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

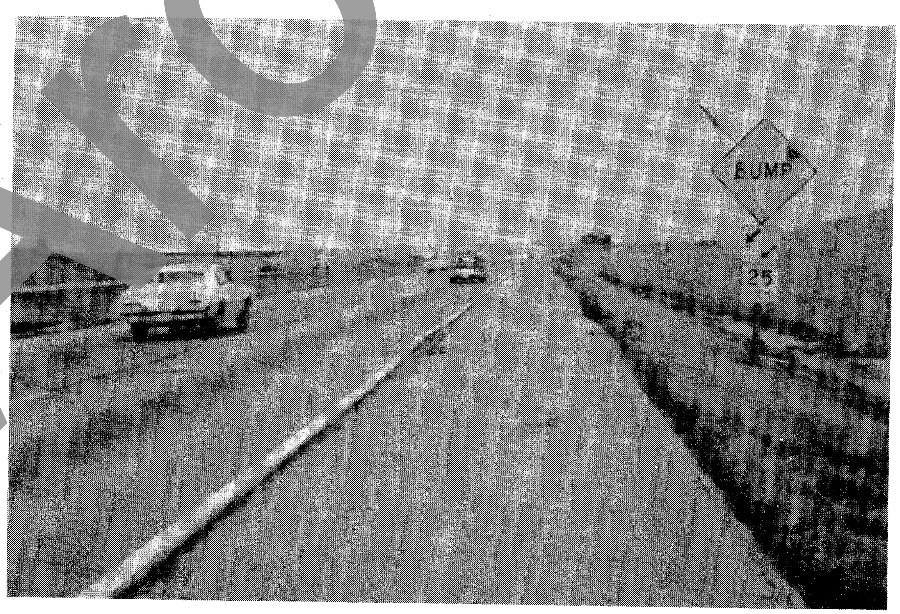

Figure 4.51. Swell Due to Frost Heave.

Figure 4.52. Swell Due to Swelling Soils.

Name of Distress: Transverse and Diagonal Cracks

Description: These cracks are usually caused by a combination of heavy load repetition, thermal and moisture gradient stresses, and drying shrinkage stresses. Medium or high severity cracks are working cracks and are considered major structural distresses. (Note: hairline cracks that are less than 6 feet (1.8 m) long are not rated.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - Working crack with a medium severity level of spalling and/or faulting less than 1/2 inch (13 mm).

H - A crack with width of opening greater than 1 inch (25 mm); a crack with a high severity level of spalling; or, a crack faulted 1/2 inch (13 mm) or more.

How to Measure: The number and severity level of each crack should be identified and recorded. If the crack does not have the same severity level along the entire length, the crack will be rated as the highest severity level present. Cracks in patches will be recorded as patch deterioration.

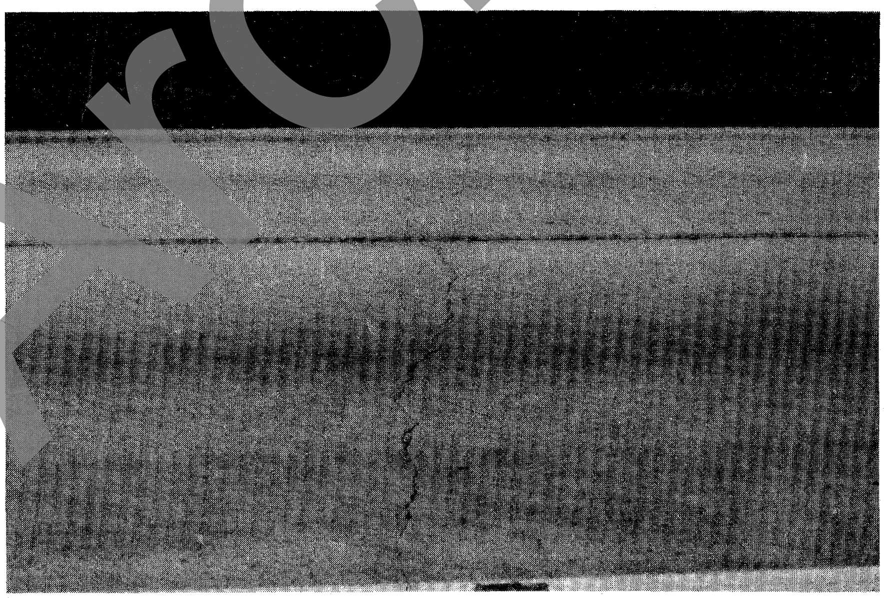

Figure 4.53. Low Severity Transverse Crack.

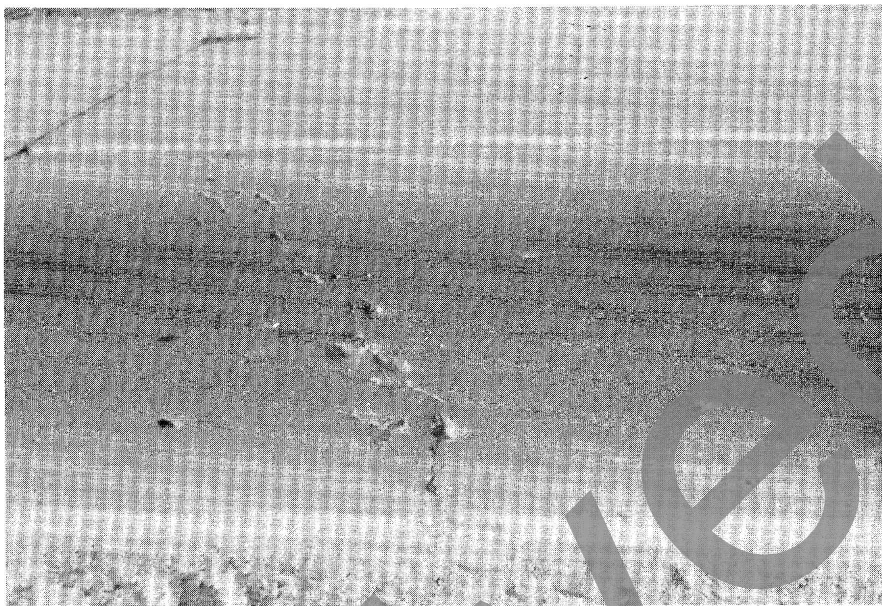

Figure 4.54. Low Severity Diagonal Crack (crack is tight even though it has some low spalling).

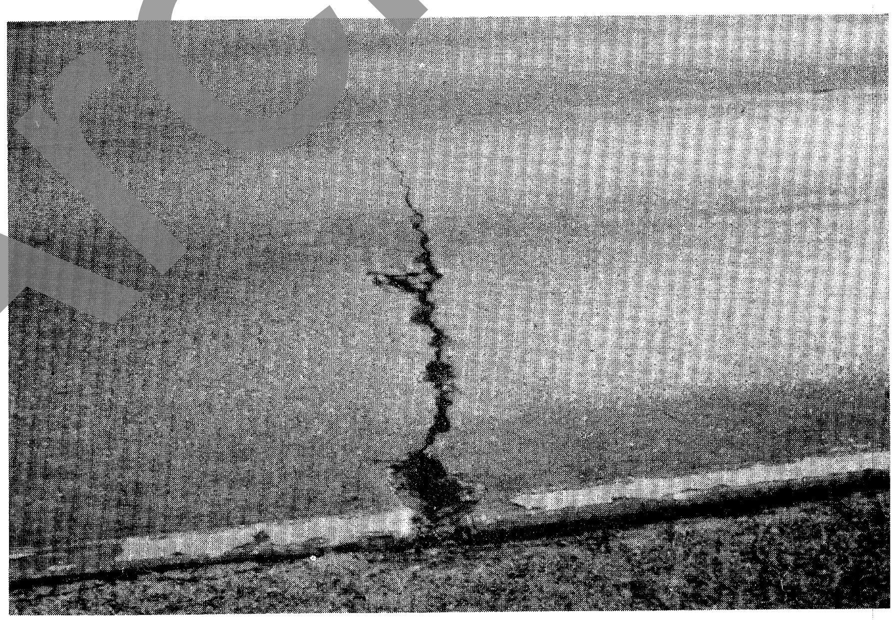

Figure 4.55. Medium Severity Transverse Crack.

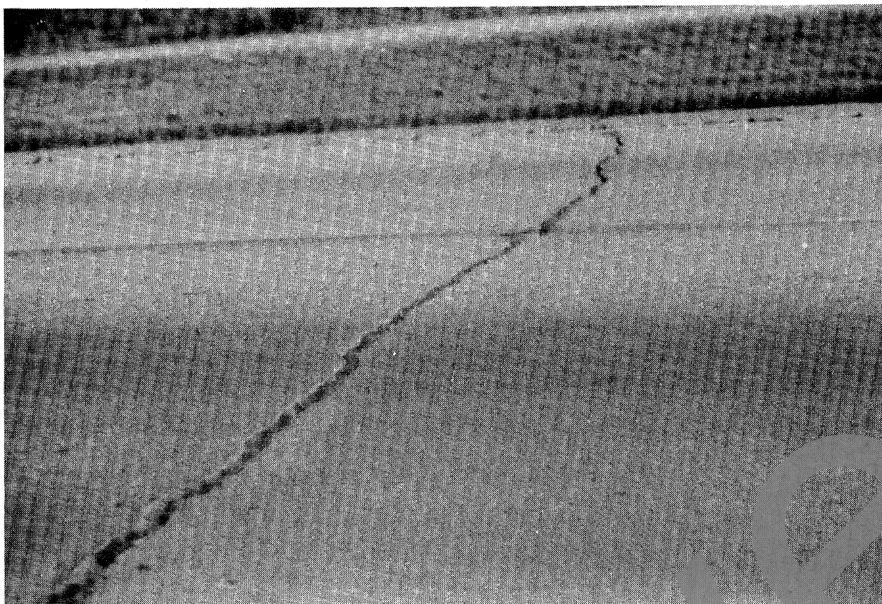

Figure 4.56. High Severity Transverse Crack.

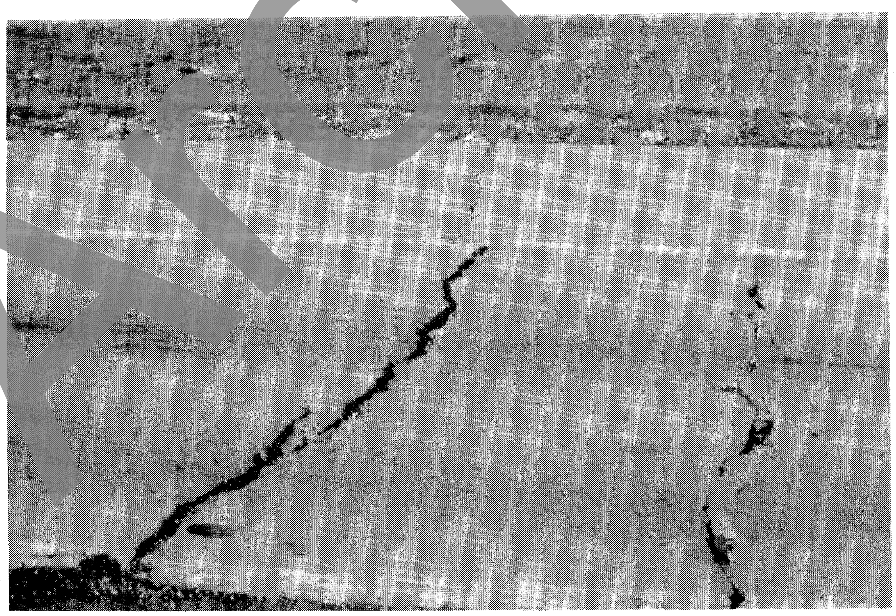

Figure 4.57. High Severity Transverse Crack.

CONTINUOUSLY REINFORCED CONCRETE DISTRESS

Name of Distress: Asphalt Patch Deterioration

Description: An asphalt patch is where a portion of the original concrete slab has been removed and replaced by a hot mix asphalt/aggregate mixture as a permanent patch.

Severity Levels:

L - Patch is functioning well with little or no deterioration.

M - Patch is somewhat deteriorated: settlement < 1/2 in. (13mm), cracking, rutting or shoving has occurred which affects the riding quality but does not cause tire damage.

H - Patch is badly deteriorated and affects ride quality significantly. Patch presents tire damage potential. Patch needs to be replaced or repaired soon.

How to Measure: The number of patches at each severity level within the inspection unit are counted and recorded. Patching is measured in square feet or square meters of area.

Figure 5.1. Low Severity Asphalt Patch Deterioration.

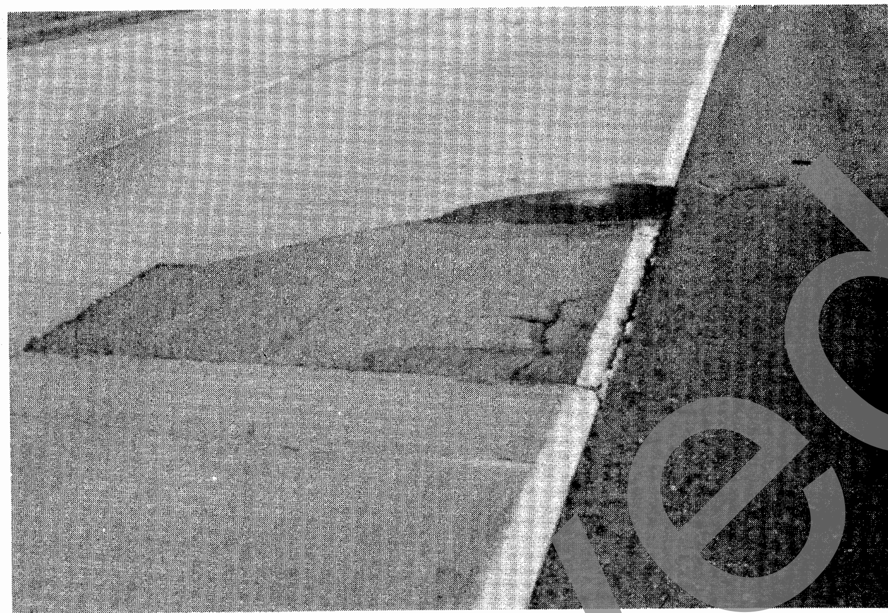

Figure 5.2. Medium Severity Asphalt Patch Deterioration (same patch as Figure 5.1 after 2 years).

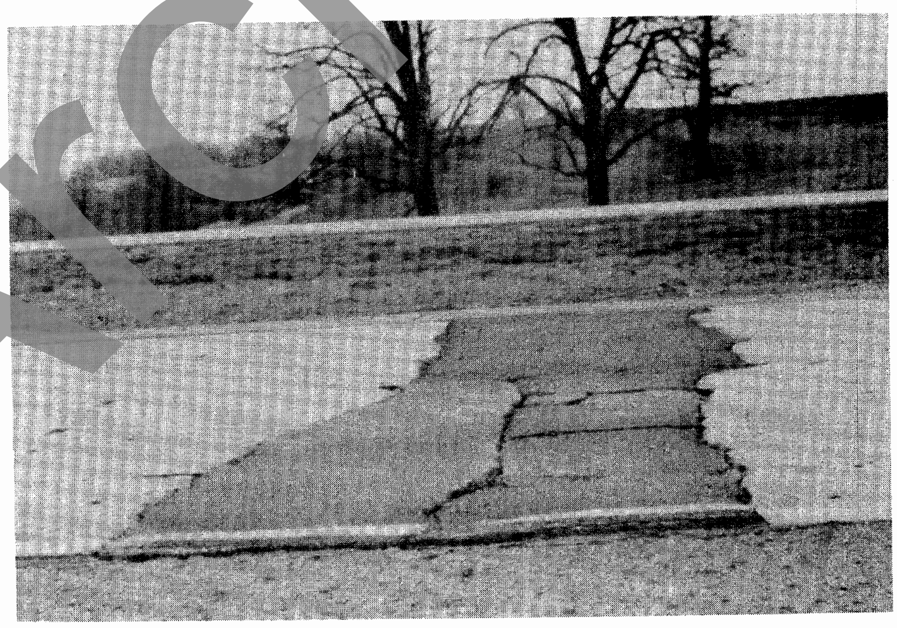

Figure 5.3. High Severity Asphalt Patch Deterioration.

Name of Distress: Blow-up

Description: Blow-ups are caused by a combination of thermal and moisture expansive forces which exceed the pavement system's ability to absorb, in conjunction with a pavement discontinuity. Blow-ups occur at construction joints or at wide transverse cracks at which the steel has previously ruptured. The result is a localized upward movement (buckling) of the slab at the edges of the crack or construction joint accompanied by shattering of the concrete in that area, or a crushing of the slab in that area.

Severity Levels:

L - Buckling or shattering has occurred, but only causes some bounce of the vehicle which creates no discomfort.

M - Buckling or shattering causes a significant bounce of the vehicle which creates some discomfort. Temporary patching has been placed because of a blow-up.

H - Buckling or shattering causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: The number of blow-ups with each severity level in the inspection unit will be counted and recorded separately. Severity levels are determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs(13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

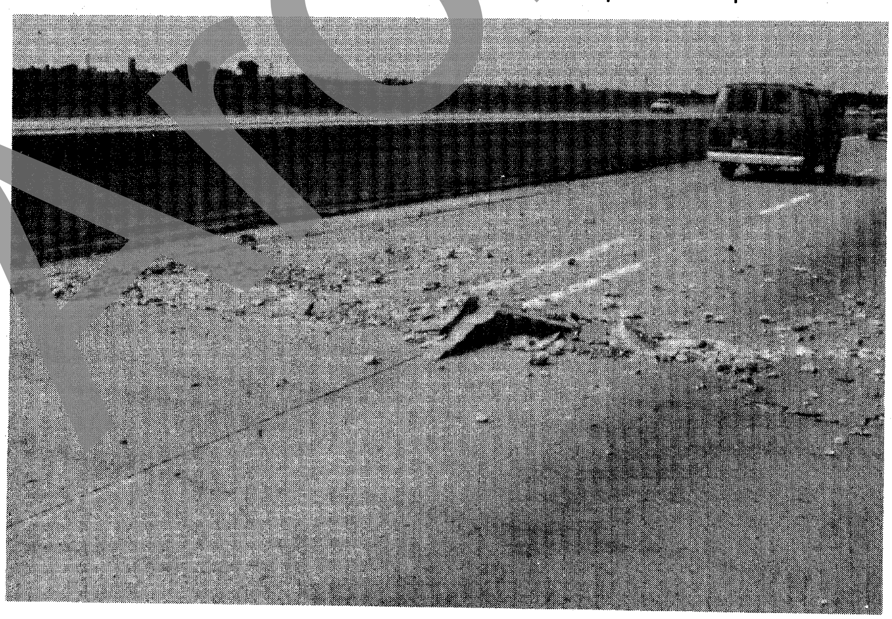

Figure 5.4. High Severity Blow-up.

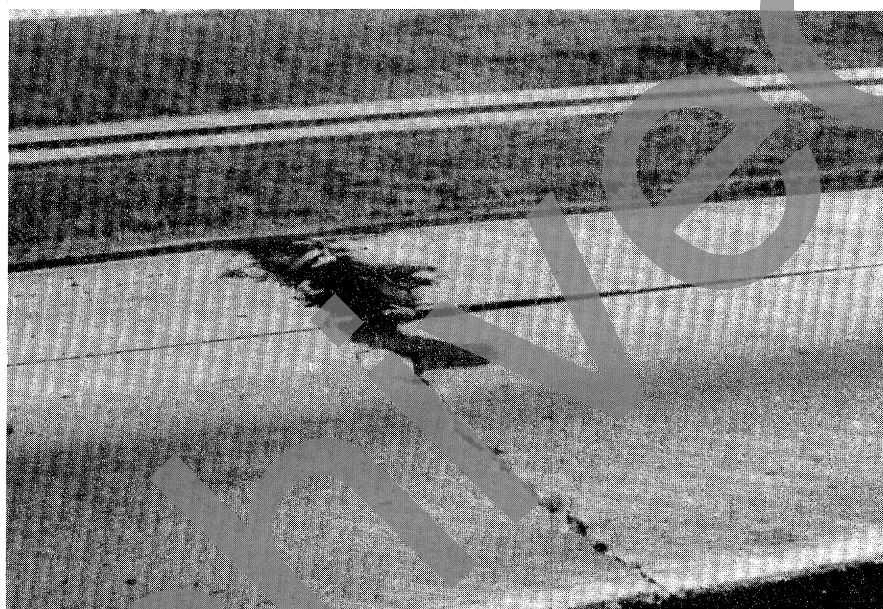

Figure 5.5. High Severity Blow-up.

Name of Distress: Concrete Patch Deterioration

Description: A concrete patch is an area where a portion of the original concrete slab has been removed and replaced by concrete or other rigid (i.e., epoxy) material.

Severity Levels:

L - Patch is functioning well with little or no deterioration. All cracks and edge joints are tight (hairline) with no spalling.

M - Patch is somewhat deteriorated: some low severity level spalling and/or faulting around the edges and/or cracks in the patch exists.

H - Patch has deteriorated either by cracking, faulting and/or spalling around the edges of the patch or within the patch to a state which warrants replacement.

How to Measure: The number of patches at each severity level within the inspection unit are counted and recorded. Patching is measured in square feet or square meters or area.

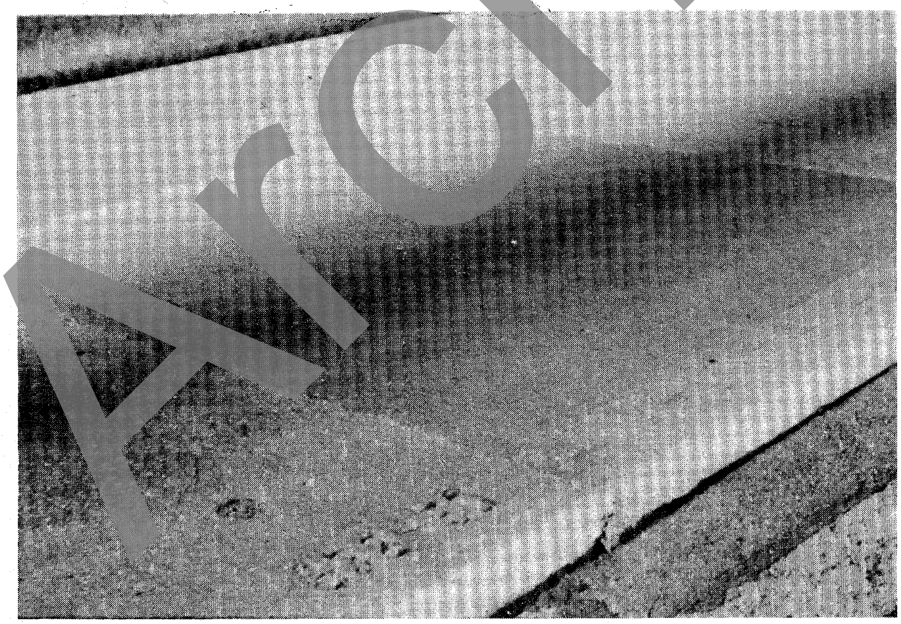

Figure 5.6. Low Severity Concrete Patch Deterioration.

Figure 5.7. Medium Severity Concrete Patch Deterioration.

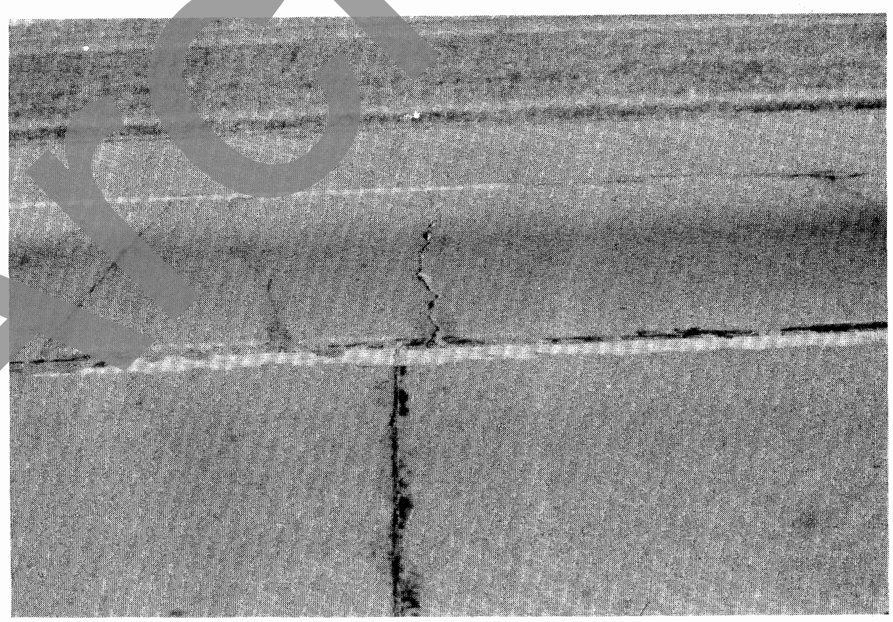

Figure 5.8. Medium Severity Concrete Patch Deterioration.

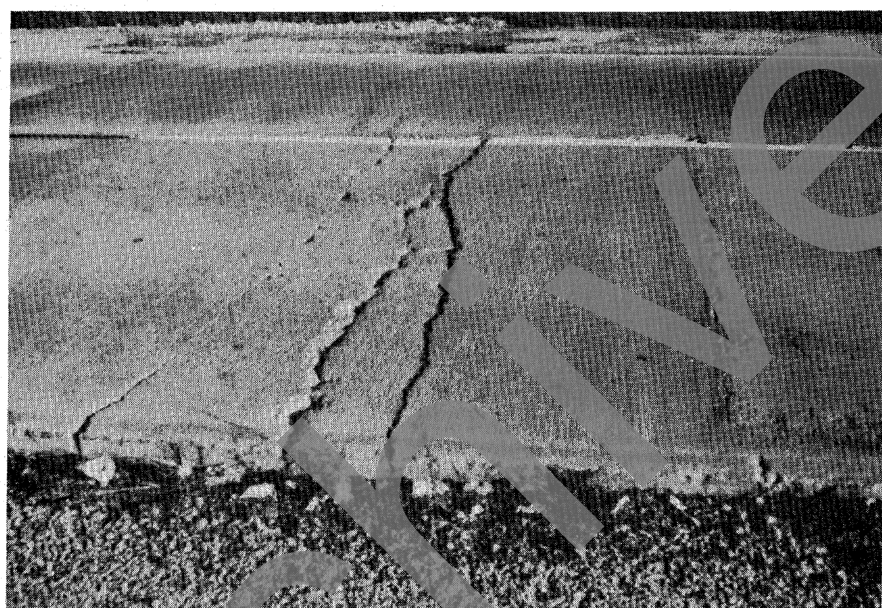

Figure 5.9. High Severity Concrete Patch Deterioration.

Name of Distress: Construction Joint Deterioration

Description: Construction joint distress is a breakdown of the concrete or steel at a CRCP construction joint. It often results in a series of closely spaced transverse cracks near the construction joint or a large number of interconnecting cracks. These excessive cracks can, in time, lead to spalling and breakup of the concrete. If an inadequate steel lap or a steel rupture occurs at a construction joint, the result is often spalling and disintegration of the surrounding concrete, and a possible pumpout. This can also lead to a readily accessible entrance for water. The primary causes of construction joint distress are poorly consolidated concrete and inadequate steel content or placement.

Severity Levels:

L - Only closely spaced tight cracks with no spalling or fautling occur within 10 ft (2 m) of each side of construction joint.

M - Some low severity spalling of cracks, or a low severity punchout exists within 10 ft (2 m) of either side of the construction joint. Temporary patching has been placed.

H - Significant deterioration and breakup exists within 10 ft. (2 m) of the construction joint, that requires patching.

How to Measure: The number of construction joints at each severity level is noted and recorded.

Figure 5.10. High Severity Construction Joint Deterioration.

Figure 5.11. High Severity Construction Joint Deterioration.

Name of Distress: Depression

Description: Depressions in concrete pavements are surface areas having elevations lower than those of the surrounding pavement. There is generally significant slab cracking in these areas due to uneven settlement. In many instances, light depressions are not noticeable until after a rain when ponding water creates "bird-bath" areas. The depressions may also be located without rain by stains caused by oil droppings from vehicles. Depressions can be caused by settlement or consolidation of the foundation soil or can be "built in" during construction. They are frequently found above culverts. This is usually caused by improper compaction of soil around the culvert during construction. Depressions cause slab cracking, roughness, and hydroplaning when filled with water of sufficient depth.

Severity Levels:

L - Depression causes some bounce of the vehicle which creates no discomfort.

M - Depression causes significant bounce of the vehicle which creates some discomfort.

H - Depression causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: Depressions are measured by counting the number that exists in each inspection unit. Each depression is rated according to its level of severity. Severity level is determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

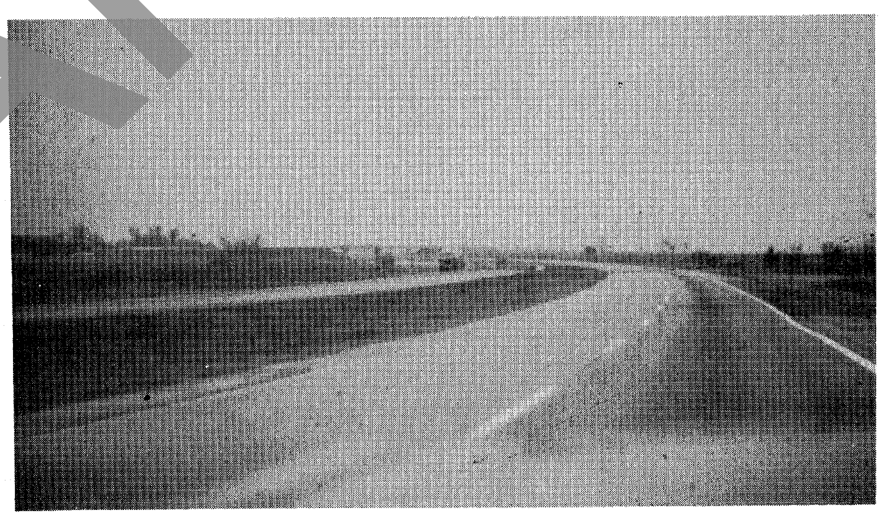

Figure 5.12. Depression.

Name of Distress: Durability ("D") Cracking

Description: "D" cracking is the name applied to concrete deterioration identified by a series of closely spaced crescent-shaped hairline cracks that appear in a PCC pavement slab adjacent and roughly parallel to transverse cracks, longitudinal joints, and free edges of pavement slabs. These fine surface cracks often curve around the intersection of longitudinal joints and transverse cracks. The surface cracks often contain calcium hydroxide residue which causes a dark coloring of the crack and immediate surrounding area. This may eventually lead to disintegration (i.e., spalling) of the concrete within 1-2 ft. (1.3-0.6 m) or more of the joint or crack, particularly in the wheelpaths. "D" cracking is caused by freeze-thaw expansive pressure of certain types of coarse aggregates. Concrete durability problems caused by reactive aggregates are rated under "Reactive Aggregate Distress."

Severity Levels: "D" cracking should not be counted if the fine crack network has not developed near transverse cracks, longitudinal joints or free edges. Discoloration or staining of joints, cracks or free edges may exist that are not "D" cracking associated. Popouts may be present without "D" cracking.

L - The characteristic fine crack pattern of closely spaced fine cracks has developed near cracks, joints or free edges; however, the width of the affected area is generally < 12 inches (30 cm) wide at transverse cracks at the center of the lane. The crack pattern may fan out at the intersection with longitudinal joints or free edges. No spalling has occurred, and no patches have been placed because of "D" cracking.

M - A fine crack pattern has developed near the crack, joint or free edge and: (1) the affected area around transverse cracks exceeds 12 in. (30 cm) in width at the center of the lane; or (2) low or medium severity spalling has developed in the affected area around the joint, crack, or free edge; or (3) temporary patches have been placed due to "D" cracking.

H - The pattern of fine cracks has developed near cracks, joints and free edges and: (1) the pattern has developed generally over the entire slab area between transverse cracks; and/or (2) high severity spalling has developed in the affected areas.

How to Measure: "D" cracking is measured by rating the longitudinal joints and each transverse crack affected according to its severity level.

Figure 5.13. Low Severity "D" Cracking.

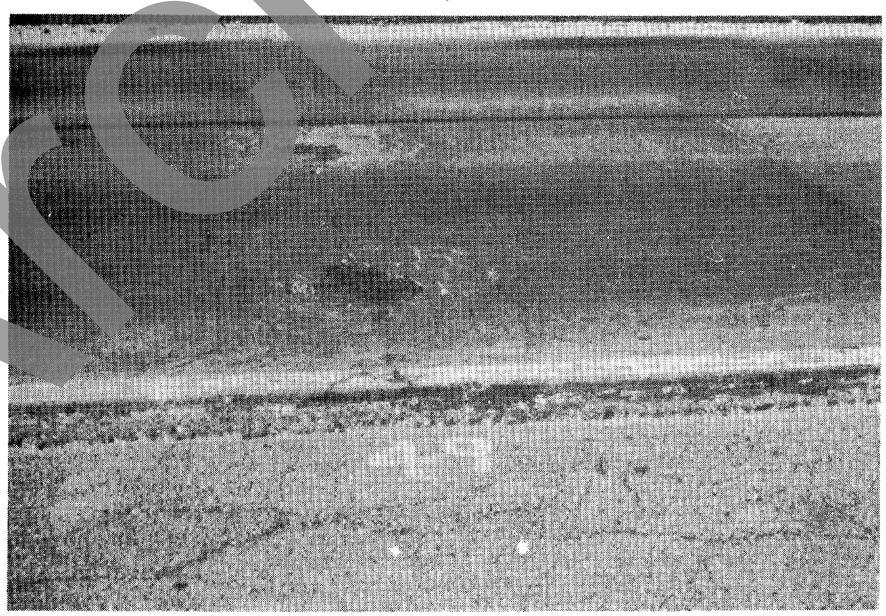

Figure 5.14. Medium Severity "D" Cracking.

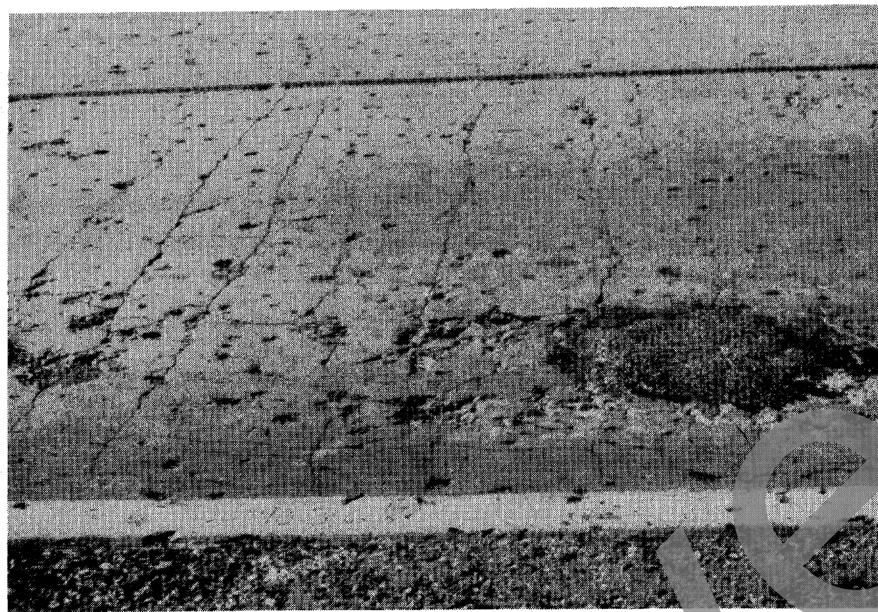

Figure 5.15. High Severity "D" Cracking.

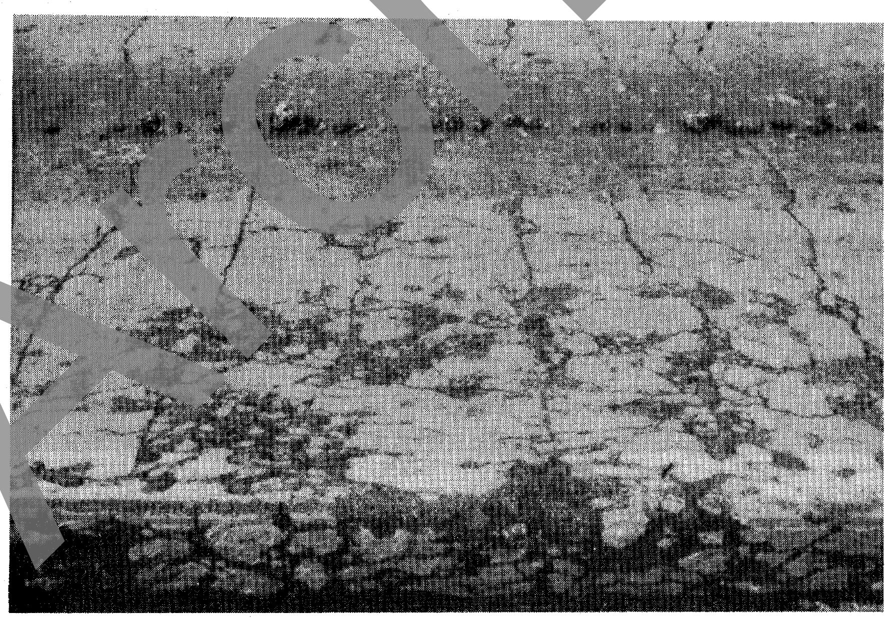

Figure 5.16. High Severity "D" Cracking (note exposed edge of slab at bottom of photo).

Name of Distress: Edge Punchout

Description: An edge punchout is first characterized by a loss of aggregate interlock at one or two closely spaced cracks (i.e., usually less than 48 in. (122 cm) apart) near the edge joint. The crack or cracks begin to fault and spall slightly which causes the portion of the slab between the closely spaced cracks to act essentially as a cantilever beam. As heavy truck load applications continue, a short longitudinal crack forms between the two transverse cracks about 24-60 in. (61-152 cm) from the pavement edge. Eventually the transverse cracks breakdown further, the steel ruptures and the pieces of concrete punch downward under load into the subbase and subgrade. There is generally evidence of pumping near edge punchouts, and sometimes extensive pumping. The distressed area will expand in size to adjoining cracks and develop into a very large area if not repaired. The edge punchout is the major structural distress of CRCP.

Severity:

L - A longitudinal crack develops between two closely spaced transverse cracks. The longitudinal and transverse cracks are fairly tight and only slight faulting spalling is present.

M - The transverse and/or longitudinal cracks have begun to widen and spall with faulting or punching down of the concrete less than 1/2 inch (13 mm).

H - The concrete within the boundary of the punchout is breaking up, has been punched down into the subbase more than 1/2 inch (13 mm) and/or has an asphalt patch on top. If the area has been asphalt patched with asphalt it is still considered a punchout and not an asphalt patch since this is only a temporary patch.

How to Measure: The number of edge punchouts and their level of severity are recorded for each inspection unit.

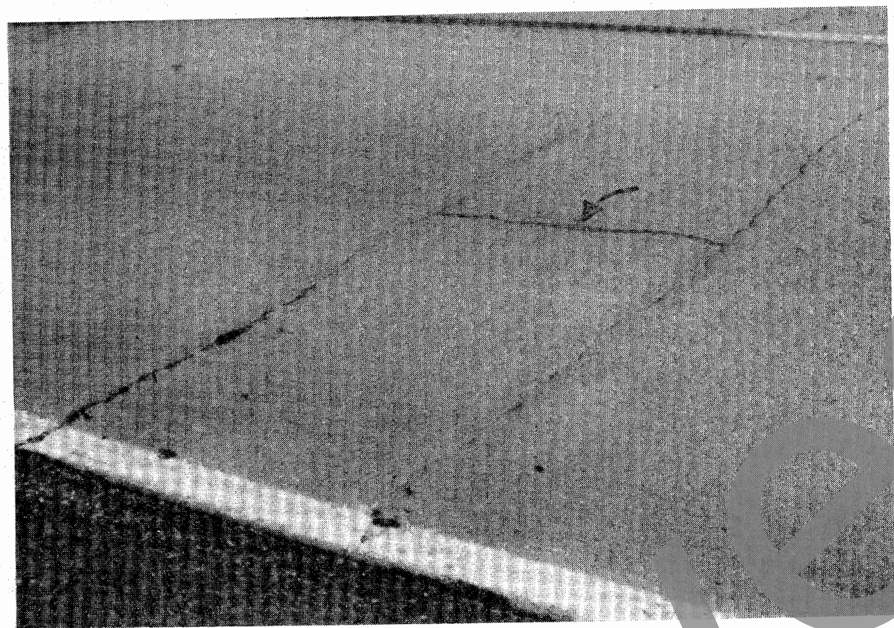

Figure 5.17. Low Severity Edge Punchout (Note: a fine longitudinal crack has developed between the two closely spaced transverse cracks).

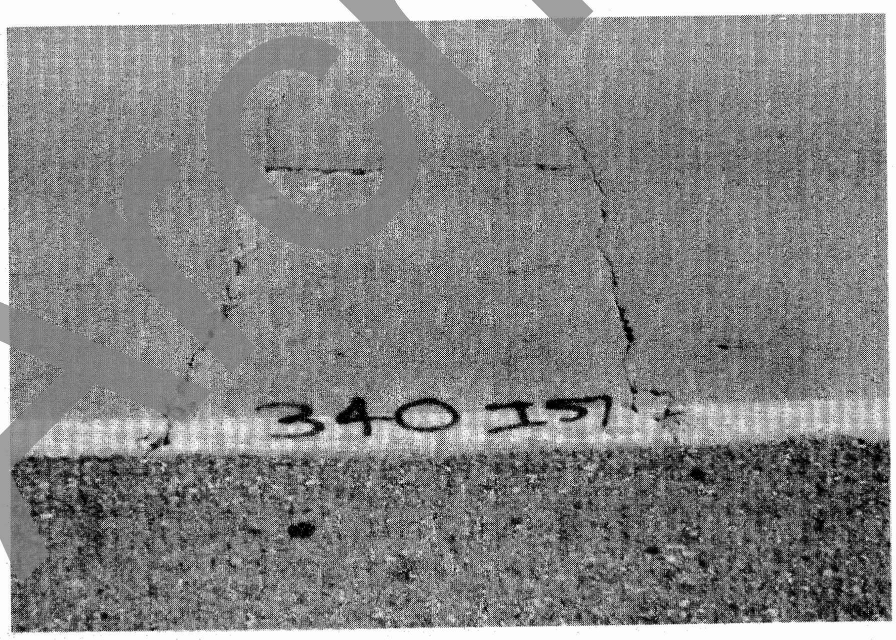

Figure 5.18. Medium Severity Edge Punchout (this photo is same edge punchout as Figure 5.17 after one year).

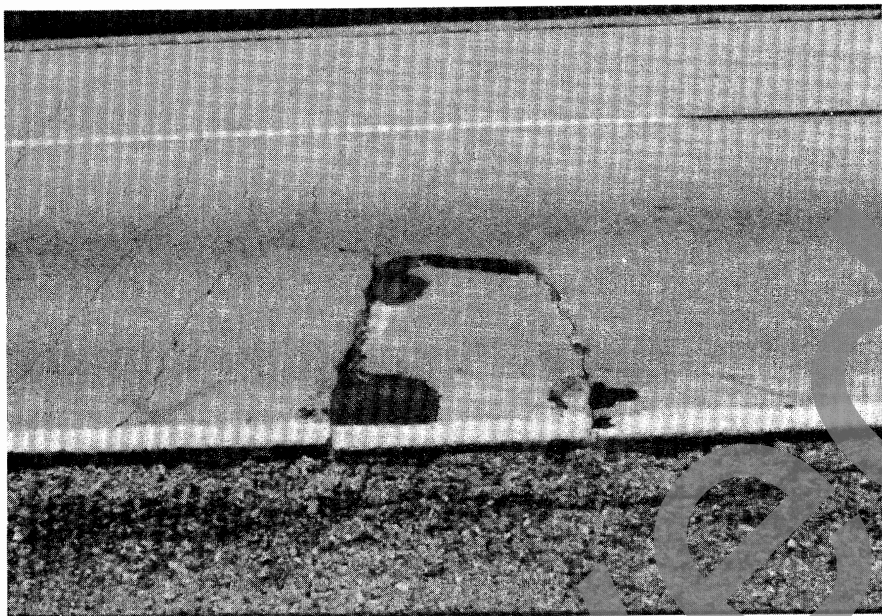

Figure 5.19. Medium Severity Edge Punchout.

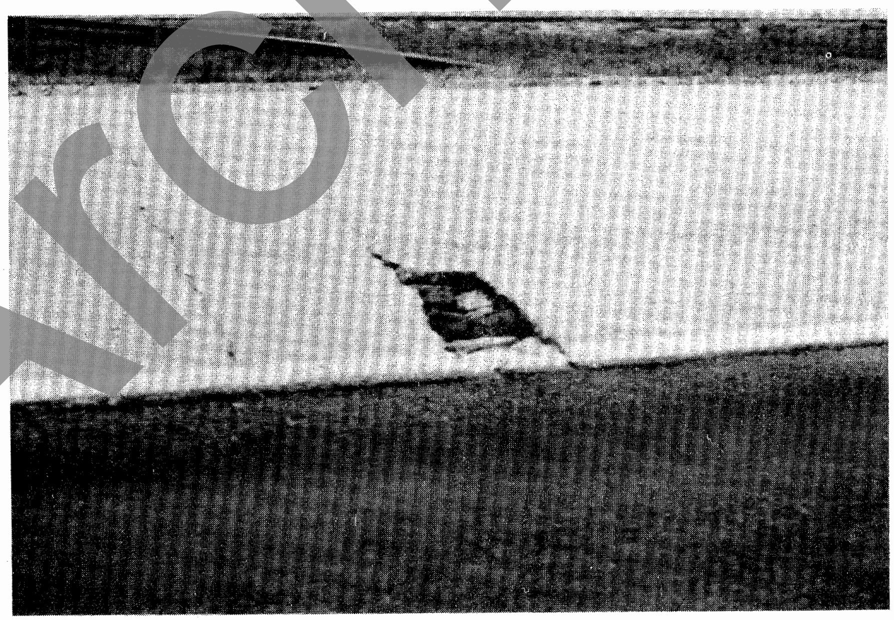

Figure 5.20. High Severity Edge Punchout.

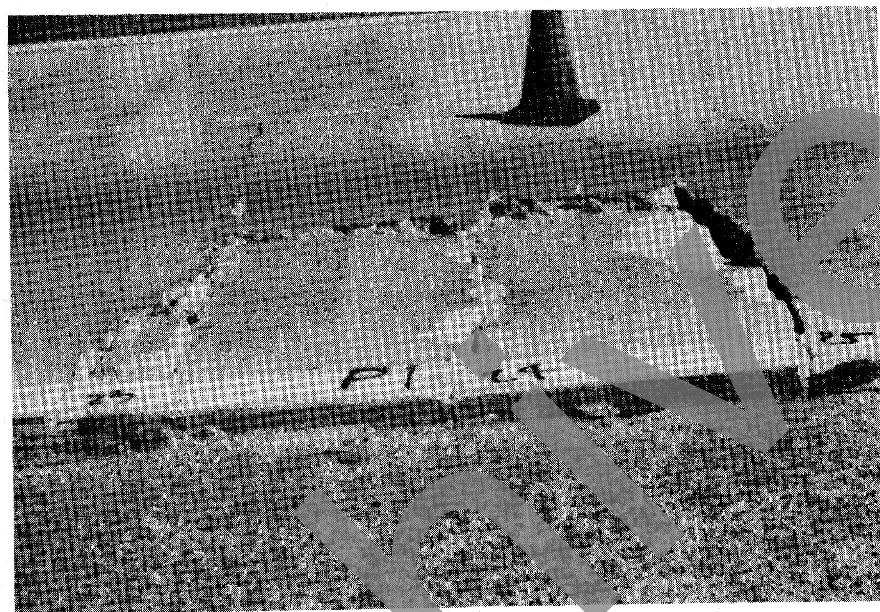

Figure 5.21. High Severity Edge Punchout.

Name of Distress: Lane/Shoulder Dropoff or Heave

Description: Lane/Shoulder dropoff or heave occurs wherever there is a difference in elevation between the traffic lane and shoulder. Typically the outside shoulder settles due to consolidation or a settlement of the underlying granular or subgrade material, or pumping of the underlying material. Heave of the shoulder may occur due to frost action or swelling soils. Dropoff of granular or soil shoulder is generally caused from blowing away of shoulder material from passing trucks.

Severity Level: Severity level is determined by computing the mean difference in elevation between the traffic lane and shoulder:

L	1/4 - 1/2 in.	(6 - 13 mm)
M	1/2 - 1 in.	(3 - 25 mm)
H	> 1 in.	(> 25 mm)

How to Measure: Lane/shoulder dropoff or heave is measured every 100 ft. (30 m) in inches (or mm) along the joint. The mean difference in elevation is computed from the data and used to determine severity level.

Figure 5.22. High Severity Lane/Shoulder Dropoff.

Figure 5.23. High Severity Lane/Shoulder Heave.

Name of Distress: Lane/Shoulder Joint Separation

Description: Lane/Shoulder joint separation is the widening of the joint between the traffic lane and the shoulder generally due to movement in the shoulder. If the joint is tightly closed or well sealed so that water cannot infiltrate, then lane/shoulder joint separation is not considered a distress.

Severity Level: Severity level is determined by the mean joint opening. No severity level is counted if the joint is tightly sealed.

L - Some opening but less than or equal to 0.1 (3 mm).

M - More than 0.12 inch (3 mm) but equal to or less than 0.4 inch (10 mm) opening.

H - More than 0.4 inch (10 mm) opening.

How to Measure: Lane/shoulder joint separation is measured in inches (mm) at 100 foot (30 m) intervals. The mean separation is used to determine the severity level for the entire inspection unit.

Figure 5.24. Medium Severity Lane/Shoulder Joint Separation (asphalt shoulder).

Figure 5.25. High Severity Lane/ Shoulder Joint Separation (concrete shoulder).

Name of Distress: Localized Distress

Description: A localized area of slab where the concrete has broken up into pieces or spalled. The localized distress takes many shapes and forms. Many times it occurs within an area between intersecting, Y-shaped or closely spaced cracks. Localized distress can occur anywhere on the slab surface, but is frequently located in the wheelpaths. Inadequate consolidation of concrete is often a primary cause of localized distress.

Severity Levels:

L - A low severity spalling or breakup of the concrete has occurred.

M - A moderate amount of spalling or breakup of the concrete has developed, or temporary patching has been placed because of the localized distress.

H - High severity spalling and/or settlement of the concrete has developed resulting in a definite safety hazard.

How to Measure: The number of localized distress areas are counted and recorded at each severity level in the inspection unit.

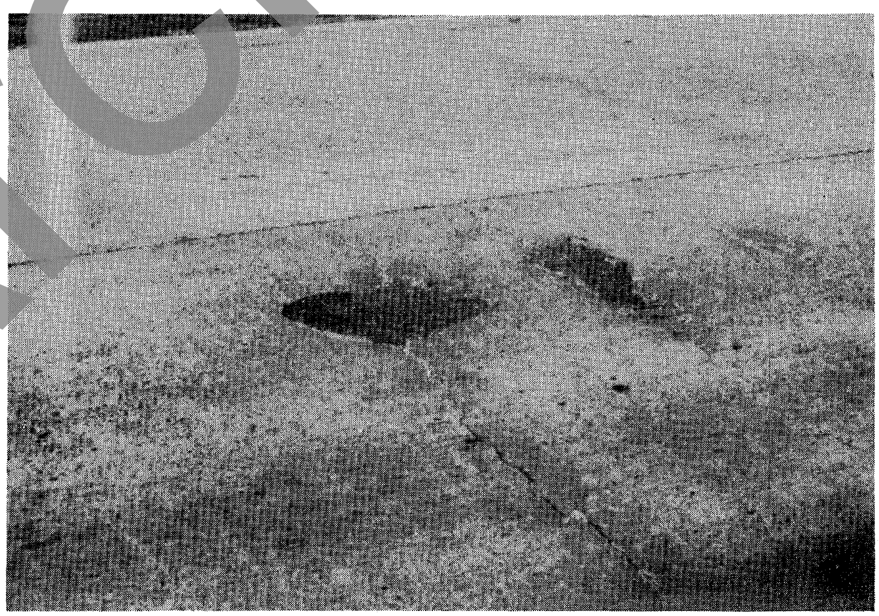

Figure 5.26. Medium Severity Localized Distress.

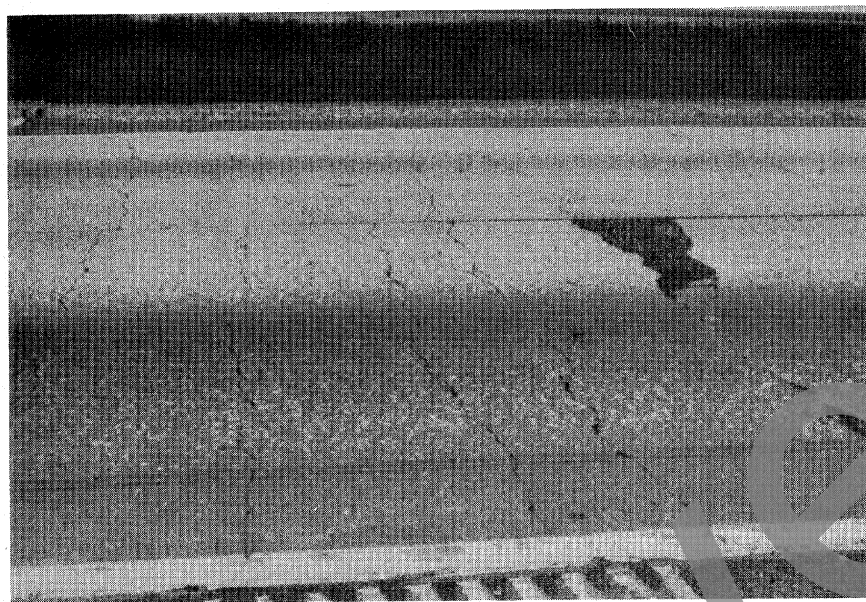

Figure 5.27. Medium Severity Localized Distress.

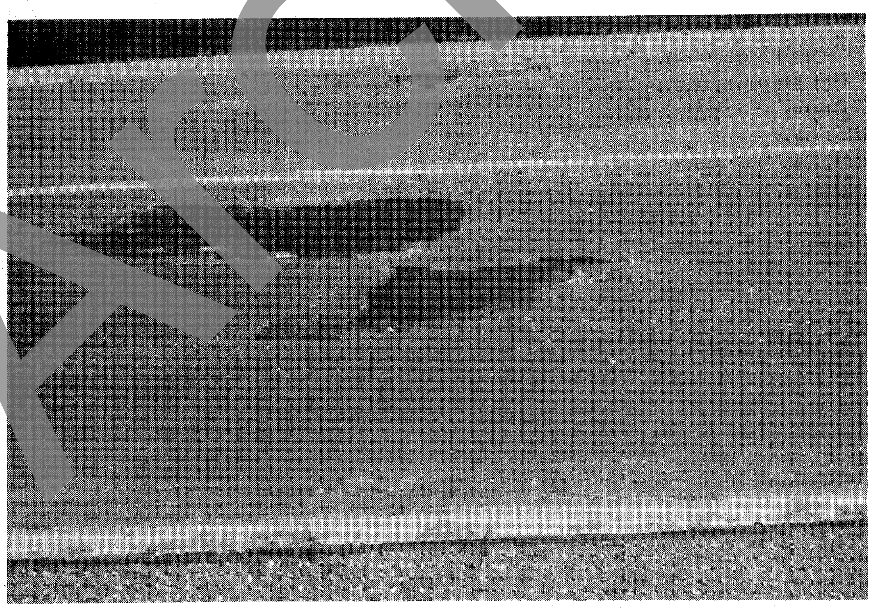

Figure 5.28. Medium Severity Localized Distress.

Figure 5.29. Medium Severity Localized Distress.

Figure 5.30. Medium Severity Localized Distress.

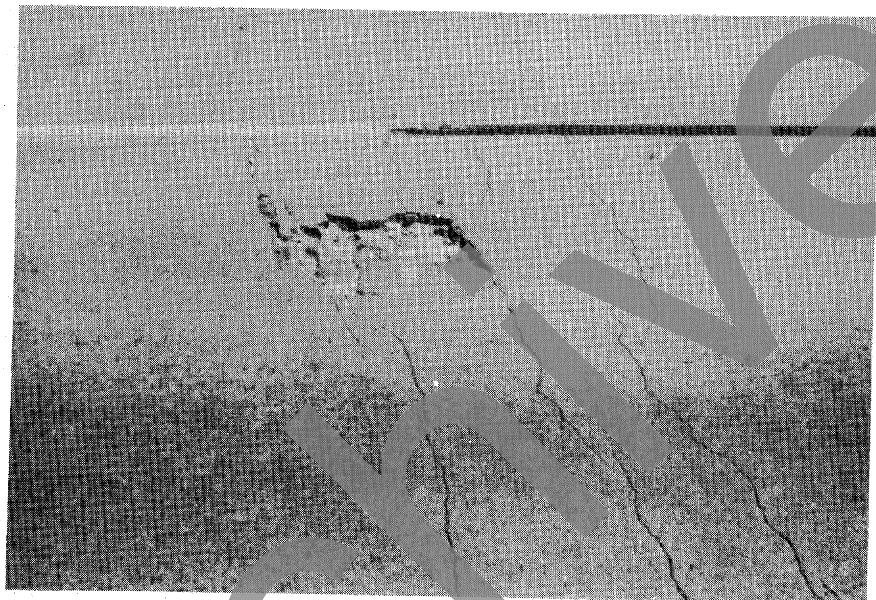

Figure 5.31. High Severity Localized Distress.

Name of Distress: Longitudinal Cracks

Description: Longitudinal cracks occur generally parallel to the centerline of the pavement. They are often caused by improper construction of longitudinal joints or by settlement or heave of the foundation.

Severity Levels:

L - Hairline (tight) crack with no spalling or faulting. A well sealed crack with no visible faulting or spalling.

M - A crack with a moderate or less severity level of spalling and/or faulting less than 1/2 inch (13 mm).

H - A crack with width greater than 1 inch (25 mm); a crack with a high severity level of spalling; or, a crack faulted 1/2 inch (13 mm) or more.

How to Measure: Cracks are measured in linear feet or meters for each level of distress. The length and severity of each crack should be identified and recorded. If the crack does not have the same severity level along the entire length, each general portion of the crack having a different severity level should be recorded separately.

Figure 5.32. Medium Severity Longitudinal Crack.

Name of Distress: Longitudinal Joint Faulting

Description: Longitudinal joint faulting is a difference in elevation at the longitudinal joint between two traffic lanes. Longitudinal joint separation is the widening of the longitudinal joint between two traffic lanes.

Severity Level:

L - Maximum faulting of less than 1/4 inch (6 mm).

M - Maximum faulting of 1/4 inch (6 mm) to 1/2 inch (13 mm).

H - Maximum faulting of 1/2 inch (13 mm) or more.

How to Measure: Where the longitudinal joint has faulted the length of the affected area and the maximum joint faulting and separation will be used to determine severity level.

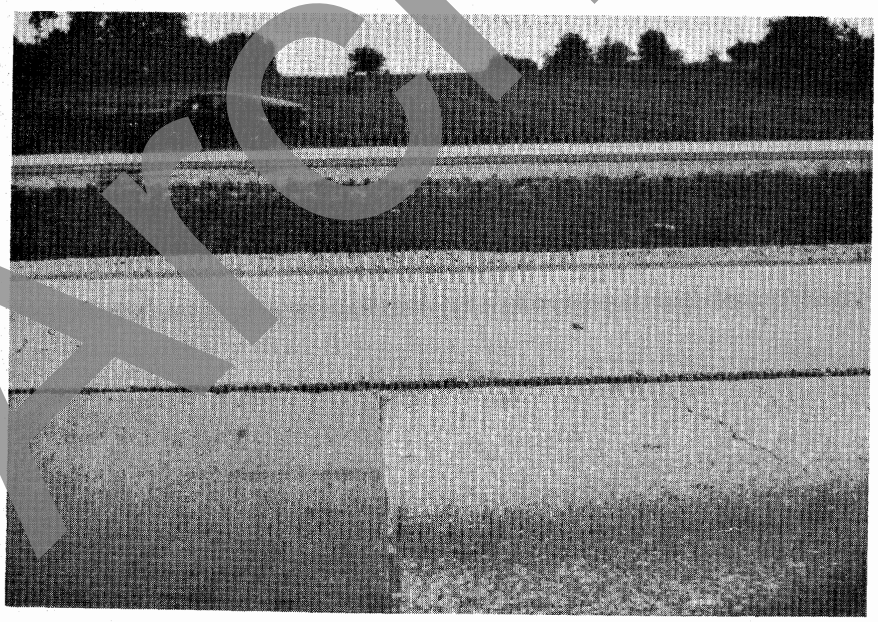

Figure 5.33. High Severity Longitudinal Joint Faulting.

Name of Distress:	Patch Adjacent Slab Deterioration
Description:	Deterioration of the original concrete slab adjacent to a permanent patch is given the above name. This may be in the form of spalling of the slab at the slab/patch joint, "D" cracking of the slab adjacent to the patch, a corner break in the adjacent slab, or a second permanent patch placed adjacent to the original patch.
Severity Level:	Severity levels are the same as that described for the particular distress found. A second permanent patch placed adjacent to a previously placed permanent patch will be rated as medium severity.
How to Measure:	The number of permanent patches with distress in the original slab adjacent to the patch at each severity level will be counted and recorded separately. Additionally, the type of patch (AC or PCC) and distress will be recorded separately.

Figure 5.34. Medium Severity Patch Adjacent Slab Deterioration (Spalling)

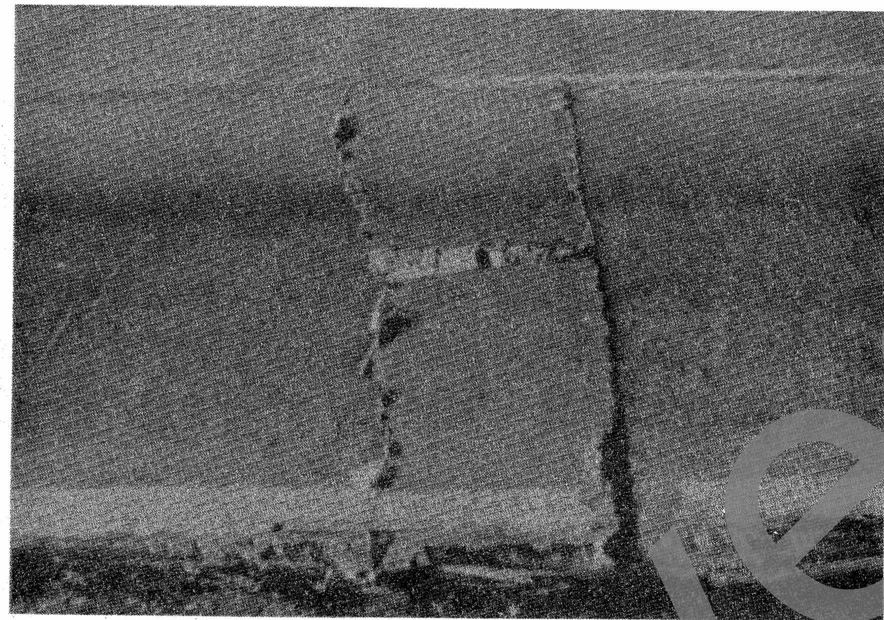

Figure 5.35. High Severity Patch Adjacent Slab Deterioration (Edge Punchout).

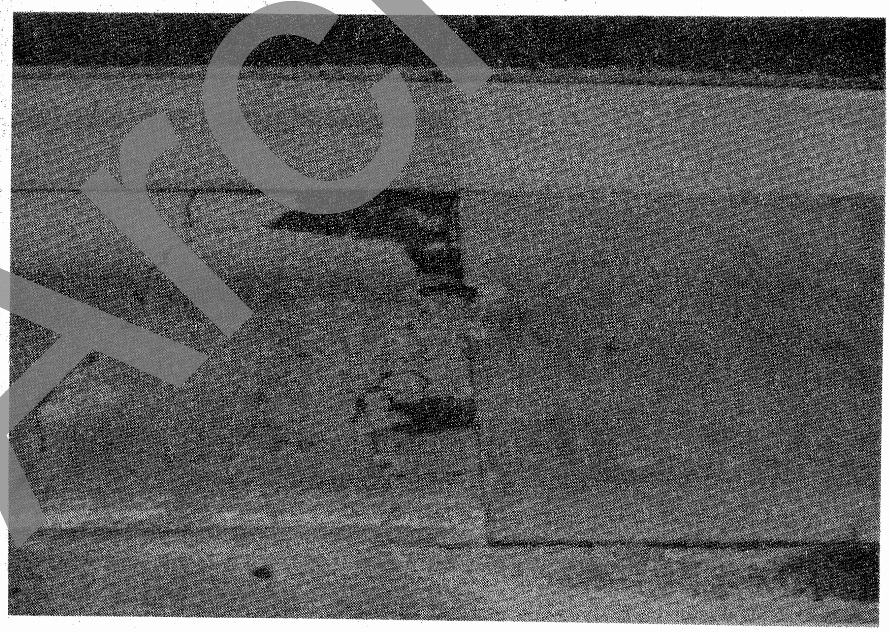

Figure 5.36. High Severity Patch Adjacent Slab Deterioration (Spalling).

Name of Distress:	Popouts
Description:	A popout is a small piece of concrete that breaks loose from the pavement surface due to freeze-thaw action, expansive aggregates, or nondurable aggregates. The occurrence of extensive popouts may be indicative of unsound aggregates and "D" cracking. Popouts usually range from approximately 1 in. to 5 in. in diameter and from 1/2 to 2 inches (13-51 mm).
Severity Level:	No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; i.e., average popout density must exceed approximately one popout per square yard (square meter) over the entire slab area.
How to Measure:	The density of popouts can be determined by counting the number of popouts per square yard of surface in areas having typical amounts.

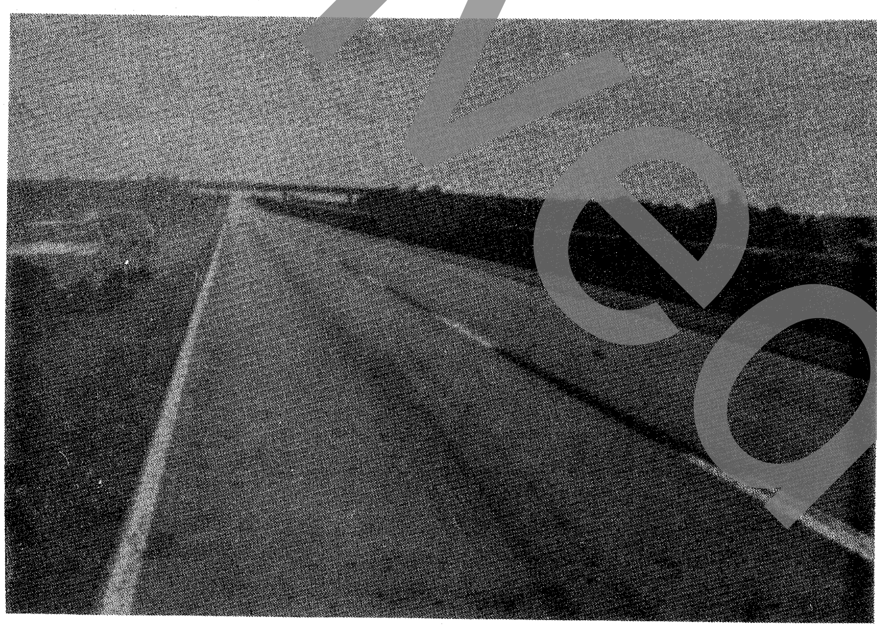

Figure 5.37. Popouts.

Name of Distress: Pumping and Water Bleeding

Description: Pumping is the ejection of material by water through joints or cracks, caused by deflection of the slab under moving loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt, resulting in a progressive loss of pavement support. Surface staining or accumulation of base or subgrade material on the pavement surface close to joints or cracks is evidence of pumping. However, pumping can occur without such evidence, particularly when stabilized bases are used. The observation of water being ejected by heavy traffic loads after a rainstrom also can be used to identify pumping. Water bleeding occurs when water seeps out of joints or cracks.

Severity Levels:

L - Water is forced out of the construction joint or crack when trucks pass over the joints or cracks, water is forced out of the lane/shoulder joint when trucks pass along the joint, or water bleeding exists. No fines can be seen on the surface of the traffic lanes or shoulder. There is evidence of the lane/shoulder joint being worn away by high pressure water.

M - A small amount of pumped material can be observed near some of the joints or cracks or on the shoulder.

H - A significant amount of pumped material exists on the pavement surface along the joints or cracks or on the shoulder.

How to Measure: If pumping or water bleeding exists anywhere in the sample unit it is counted as occurring at highest severity level noted.

Figure 5.38. Low Severity Pumping (water ejected out of transverse crack under truck wheel).

Figure 5.39. Low Severity Pumping (water ejected out of longitudinal joint under truck wheel).

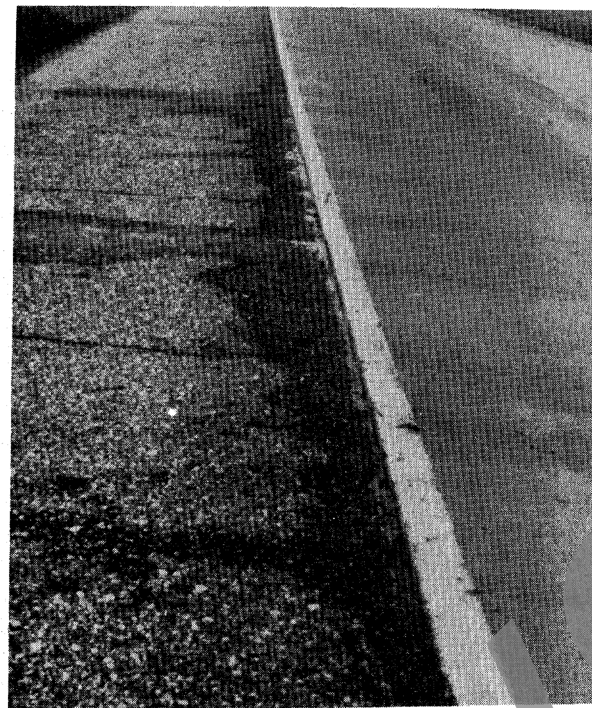

Figure 5.40. Low Severity Water Bleeding.

Figure 5.41. Medium Severity Pumping of Fines.

Figure 5.42. Medium Severity Pumping of Fines.

Figure 5.43. High Severity Pumping of Fines.

Figure 5.44. Very High Severity Pumping of Fines.

Name of Distress: Reactive Aggregate Distress

Description: Reactive aggregates either expand in alkaline environments or develop prominent siliceous reaction rims in concrete. It may be an alkali-silica reaction or an alkali-carbonate reaction. As expansion occurs, the cement matrix is disrupted and cracks. It appears as a map cracked area; however, the cracks may go deeper into the concrete than in normal map cracking. It may affect most of the slab or it may first appear at joints and cracks.

Severity Levels: Only one level of severity is defined. If alkali-aggregate cracking occurs anywhere in the slab, it is counted. If the reaction has caused spalling or map cracking, these also are counted.

How to Measure: Alkali-aggregate reaction is measured in square feet or square meters.

Name of Distress: Scaling, Map Cracking, and Crazing

Description: Map cracking or crazing refers to a network of shallow, fine, or hairline cracks which extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Map cracking or crazing is usually caused by over-finishing the concrete, and may lead to scaling of the surface, which is the breakdown of the slab surface to a depth of approximately 1/4 in. (6 mm) to 1/2 in. (13 mm). Scaling may be caused by deicing salts, improper consturction and freeze-thaw cycles.

Severity Levels:

L - Crazing or map cracking exists over most of the slab area; the surface is in good condition with no scaling (Note: the low severity level is an indicator that scaling may develop in the future).

M - Less than or equal to 10% of any inspection unit exhibits scaling.

H - More than 10% of any inspection unit exhibits scaling.

How to Measure: Scaling, map cracking, and crazing are measured by recording % of area affected by each type severity level.

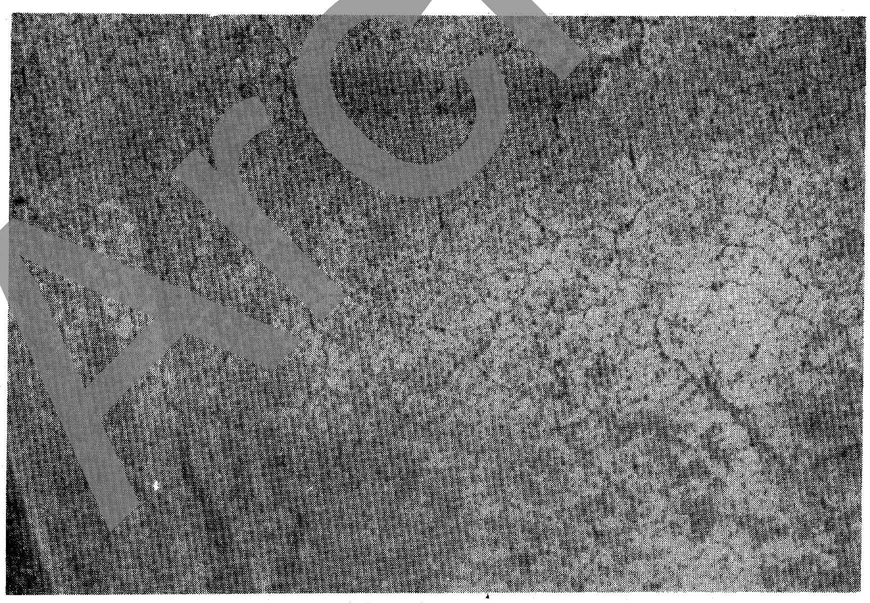

Figure 5.45. Low Severity Map Cracking or Crazing.

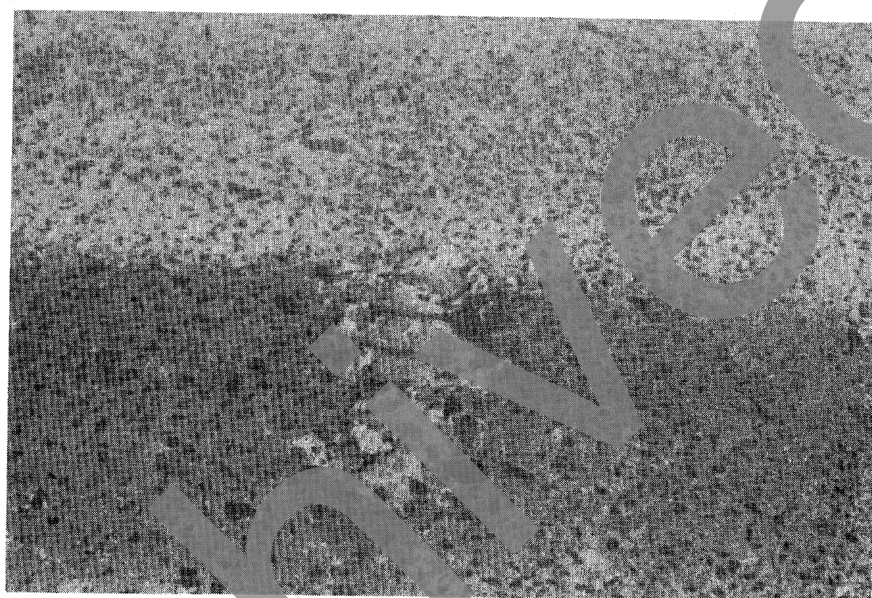

Figure 5.46. Medium Severity Scaling (steel close to surface).

Name of Distress: Spalling

Description: Spalling of cracks and joints is the breakdown or fraying of the slab edges within 2 ft. (0.6 m) of the crack or joint. A spall usually does not extend vertically through the whole slab thickness, but extends to intersect the crack or joint at an angle. Spalling usually results from (1) excessive stresses at the joint or crack caused by infiltration of incompressible materials and subsequent expansion or tarffic loading, (2) disintegration of the concrete from durability problems, (3) weak concrete at the surface (caused by overworking), or (4) a keyed longitudinal joint failure.

Severity Levels:

L - A spall less than two feet long (0.6 m); if spall is broken into pieces and fragmented, it must not extend more than three inches (76 mm) from the joint or crack. A spall more than two feet (0.6 m) long with spall held tightly in place; if spall is cracked, it cannot be broken into more than three pieces. The crack is lightly frayed with the fray extending no more than three inches from the edge of the joint or crack.

M - A spall is broken into pieces or fragmented and spall extends more than three inches (76 mm) from joint or crack. Some pieces may be loose and/or missing but the spalled area does not present a tire damage or safety hazard. The joint or crack is moderately frayed with fray extending more than three inches from the edge of the joint or crack but does not cause a tire damage or safety hazard. Temporary patching has been placed because of spalling.

H - The joint or crack is severely spalled, frayed, or faulted to the extent that a tire damage or safety hazard exists.

How to Measure: If more than one level of severity exists along a joint, it will be recorded at the highest severity level present. Spalling of construction joints will be recorded under "Construction Joint Deterioration." Spalling of longitudinal and transverse cracks will be recorded under "Longitudinal Joints" and "Transverse Cracks." Spalling of the slab edge adjacent to a permanent patch will be recorded as "Patch Adjacent Slab Deterioration." Spalling of longitudinal joints will be recorded under "Spalling."

Figure 5.47. Low Severity Spalling of Transverse Crack .

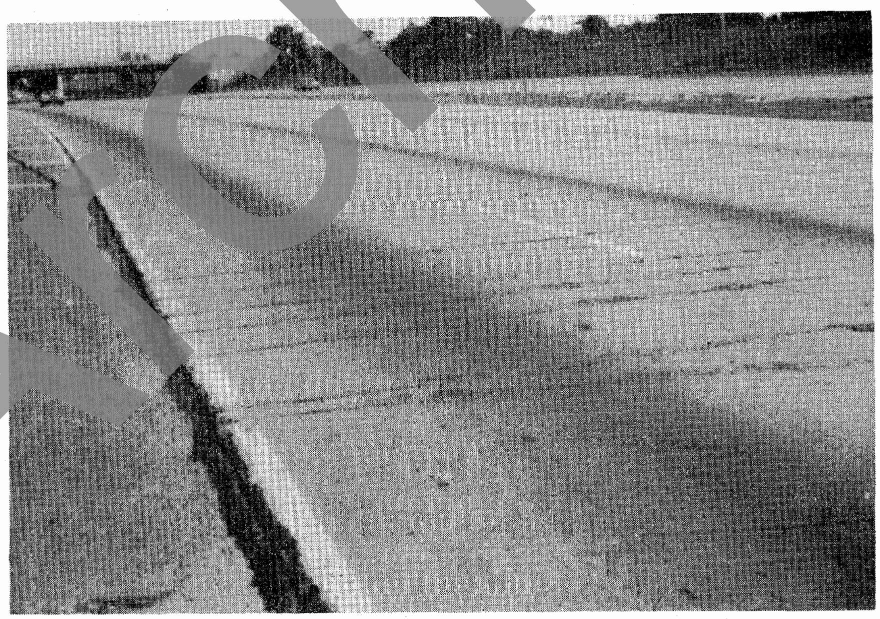

Figure 5.48. Low Severity Spalling of Transverse Cracks (these cracks are tight beneath the spalled surface).

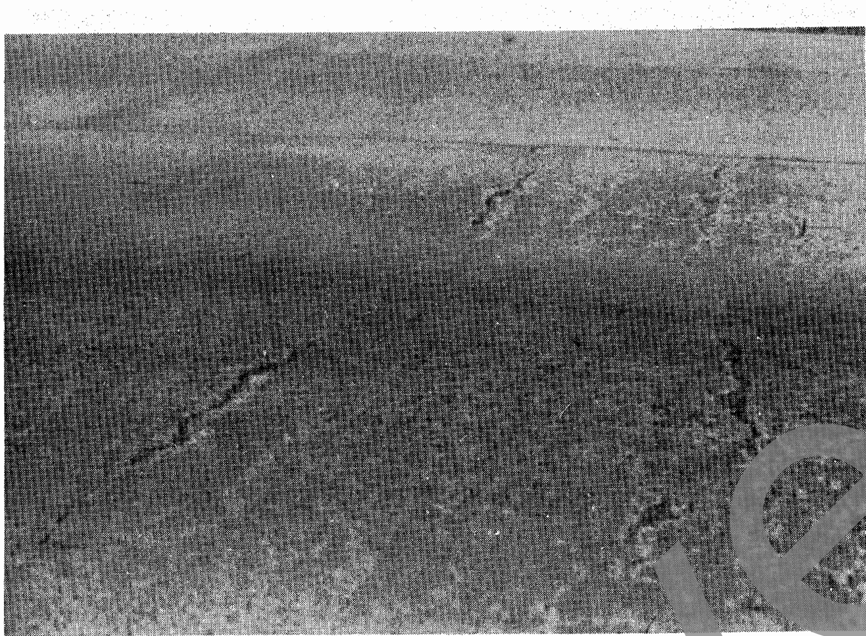

Figure 5.49. Low Severity Spalling of Transverse Cracks.

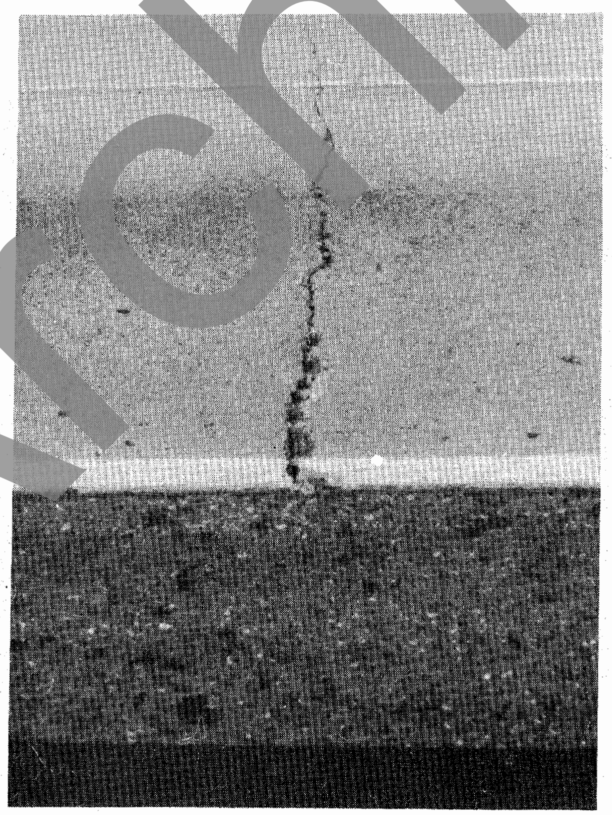

Figure 5.50. Medium Severity Spalling of Transverse Crack .

Figure 5.51. Medium Severity Spalling of Longitudinal Joint.

Figure 5.52. High Severity Spalling of Transverse Crack (Note: see Figure 5.11 for an example of high severity construction joint spalling).

Name of Distress: Swell

Description: Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell is usually accompanied by slab cracking. A swell is usually caused by frost action in the subgrade or by swelling soil. Swells can often be identified by soil droppings on the surface.

Severity Levels:

L - Swell causes some bounce of the vehicle which creates no discomfort.

M - Swell causes significant bounce of the vehicle which creates some discomfort.

H - Swell causes excessive bounce of the vehicle which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

How to Measure: The number of swells within the inspection unit are counted and recorded by severity level. Severity levels are determined by riding in a mid to full sized sedan weighing approximately 3000-3800 lbs. (13.3-16.9 kN) over the pavement inspection unit at the posted speed limit.

Figure 5.53. Swell Caused by Frost Heave (located behind truck).

Figure 5.54. Swell Caused by Frost Heave.

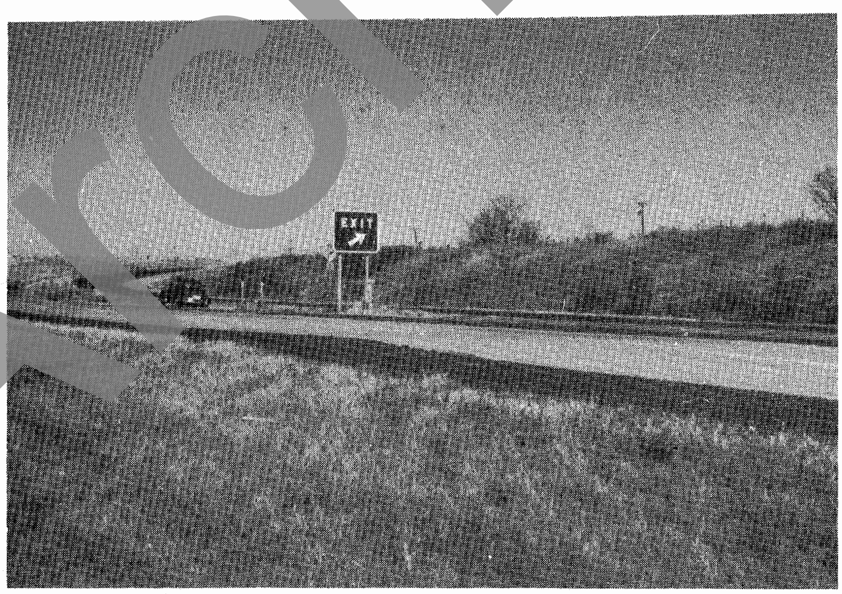

Figure 5.55. Swell Caused by Swelling Soil.

Name of Distress: Transverse Cracking

Description: Transverse cracking of continuously reinforced slabs is a normal occurrence and is not in itself considered to be a distress. As soon as the slab is placed and begins to harden, drying shrinkage of the concrete occurs. Reinforcement in the slab and subbase friction oppose the shrinkage and cracks soon form. After about 2-4 years, the crack spacing becomes constant. The purpose of the steel is to hold these random spaced transverse cracks tightly together so that load transfer across the crack will be obtained through aggregate interlock. If the steel ruptures or shears, load transfer across the crack is lost and the crack becomes a potential location for major distress. When deicing salts and water infiltrate through a wide crack, the reinforcing steel is subjected to corrosion, and the effective diameter of the steel begins to decrease. When the stresses due to temperature changes and loading are greater than the strength of the steel, the reinforcing bar ruptures. Indicators of sheared or decreased diameter reinforcing bars are faulted and/or widened spalled cracks. Some cracks may have widened substantially after steel rupture. (Note: sometimes the transverse cracks run diagonally across the pavement and intersect. Hairline cracks that are less than 3 feet long are not rated.

Severity Levels: Severity levels of transverse cracking are determined by crack spalling and faulting.

L - Tight (hairline) cracks with no faulting, steel rupture, or spalling.*

M - A crack with no steel rupture, faulting less than or equal to 0.2 inch (5 mm) and/or low severity spalling.*

H - Faulting greater than 0.2 inch (5 mm), or steel rupture, or medium to high severity spalling.*

How to Measure: Faulting is determined by measuring elevation difference across transverse cracks one foot from the slab edge. Any cracks wider than 1/8 inch (3 mm) can be assumed to have some or all steel ruptured. Thus, all cracks in the inspection unit will be identified as L, M, or H, and the number of each recorded. Mean crack spacing can be determined from this information. Cracks having a length less than six feet are not considered. All cracks within the sample unit will be sketched with severity levels indicated.

*See definition provided under "Spalling."

Figure 5.56. Low Severity Transverse Cracks.

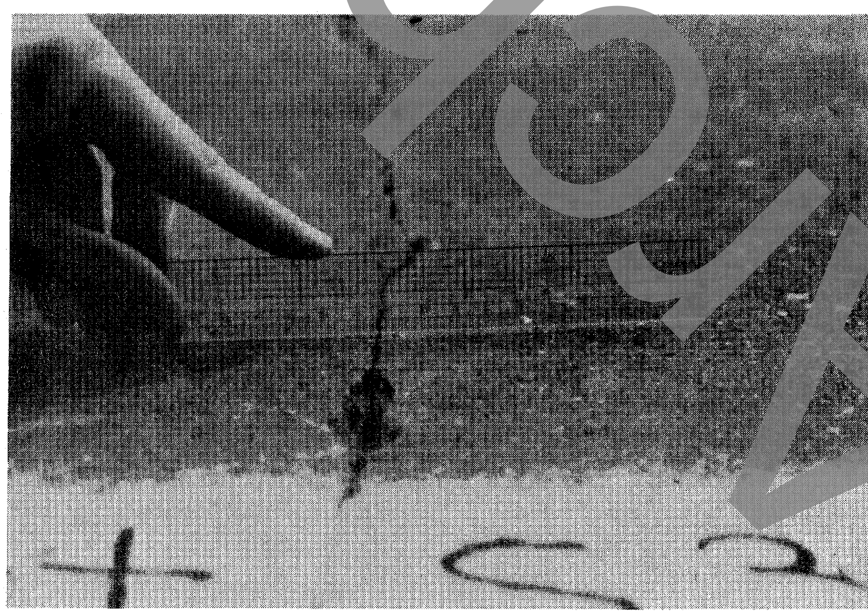

Figure 5.57. Medium Severity Transverse Crack (note faulting).

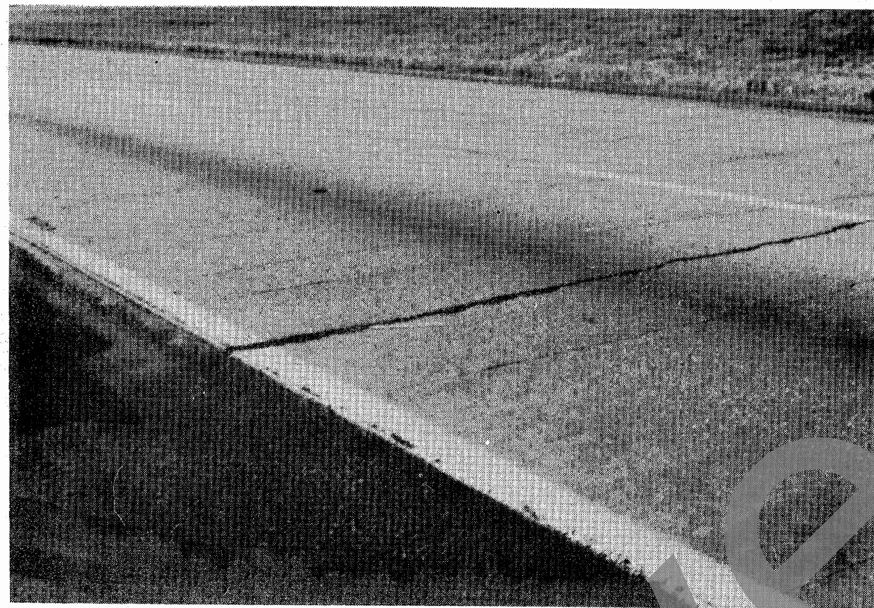

Figure 5.58. High Severity Transverse Crack.

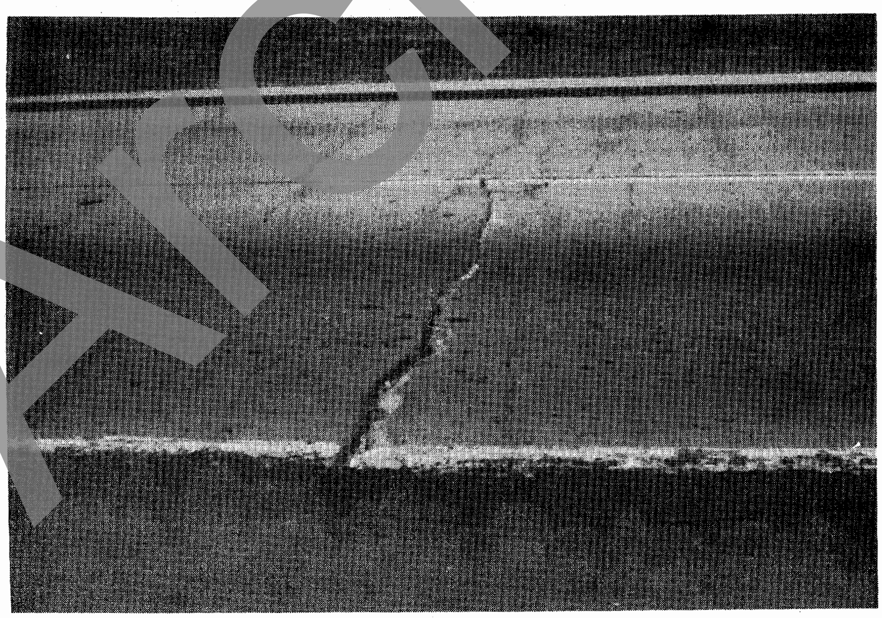

Figure 5.59. High Severity Transverse Crack.

*U.S. GOVERNMENT PRINTING OFFICE: 1986 0-491-810/20692

Figure 5.60. High Severity Transverse Crack.

HHP-12/R3-82(100)
HHO-31/R3-84(500)EWR
HHO-31/R12-84(200)EWR
HHO-31/R2-86(200)EWR