PAVEMENT SURFACE DISTRESS SURVEY MANUAL

WISCONSIN DEPARTMENT OF TRANSPORTATION

February 1993

Division of Highways
Central Office Materials
Pavement Management Section

PAVEMENT SURFACE DISTRESS SURVEY MANUAL

REVISED FEBRUARY, 1993.

Wisconsin Department of Transportation

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BACKGROUND

In 1977, the Wisconsin Department of Transportation (WisDOT) initiated the development of a *Programming process*--i.e., a method for distributing highway improvement funds based on justifiable needs--and applied that process to produce the first Six-Year Highway Improvement Program. The development of this process was in response to requirements to identify highway system needs and to develop additional technical, physical and operational data to document those needs.

Many types of data were used to support the Program development process, the primary source of information for pavement performance at that time being the Present Serviceability Index (PSI). PSI values have been somewhat effective in providing an assessment of the performance of the highway system on a network (i.e., statewide) basis. However, these values have not been good indicators of actual pavement performance. As outlined below, certain pavement surface distresses were found to be better indicators of pavement performance.

After several years experience developing the Six-Year Highway Improvement Program, WisDOT discovered that, in addition to PSI, pavement surface distress data (generally referred to as Pavement Distress Index or PDI data) is also essential for documenting and evaluating highway needs at both project and network levels. Experience also indicated that the methods developed to obtain this surface distress information must provide consistent measures that can be applied on a *system-wide* (i.e., in all Transportation districts across Wisconsin) as well as project-specific basis.

In 1980, development of a method for documenting pavement surface distress was initiated. Development was ongoing during the time-frame 1980-1985. Prototype surveys using this method were carried out in 1983 and 1984 in districts 7 and 8. Data gathered in these early surveys was generally found to be inadequate and was later discarded. In the form it had assumed by 1985, the method called for looking at various observable distresses, quantified by severity and extent, and developed an index (PDI) based on a mathematical formulation of these quantities. In 1985, rater training was conducted, and full-scale surveys (i.e., biennial statewide surveys) using the then-current method were implemented. Since then, pavement surface distress data on all of the State Trunk Highway (STH) system has been collected, stored and maintained by district and Pavement Management (PM) personnel using the method approved in 1985 with minor variations introduced in succeeding years. This manual provides techniques for pavement surface distress documentation and evaluation currently used by WisDOT.

INTRODUCTION

When the methodology presented in this manual is followed closely, the documentation of pavement condition becomes objective and consists of visually assessing the existing pavement surface for distress indicators. Surface distress indicators don't always give a full picture of the distressed condition of the pavement, but they may indicate materials and/or structural problems in addition to signs of the natural deterioration of pavements.

Despite potential deficiencies in using surface distress indicators to indicate pavement condition, the indicators selected for this manual (and measurements of their severity and extent) are sufficient for use in a statewide pavement distress inventory. This inventory when combined with specific information such as pavement type, construction history (including age and cross-section data) and materials analyses can lead to a very accurate picture of the actual condition of a paved structure. In addition, these indicators and associated specific information may lead directly to a causal relationship between observed distresses and underlying problems. Furthermore, the establishment of this relationship greatly facilitates the development of a rehabilitation scheme by district personnel.

PDI surveys and subsequent quantification of observed distresses, including calculation of a single mathematical index, also play an important role in developing the Pavement Management Decision Support System (PMDSS). One of the functions of this GIS-based application program is to assist district planners in developing rational long-range plans for maintaining and improving their highways based on forecast needs, available monies and accepted construction and rehabilitation schemes. The primary sources of information allowing the development of needs and the selection of effective rehabilitation/construction measures are the files containing PDI survey information.

In order for the various WisDOT sections to use PDI data effectively, clearly distinguishable distress indicators must be used to rate the pavements. The distress indicators used in this manual are nationally accepted indicators which are easily recognizable by trained pavement distress raters.

In addition to using accepted and readily recognized indicators, the pavement distress inventory must be conducted uniformly throughout the State. The results should be repeatable and consistent from year to year and from district to district. In order to effect this uniformity, the rater is required to use the procedures presented in this manual to record the visible surface distress. The manual contains techniques, guidelines, definitions, and procedures required to evaluate and inventory pavement surface distress. The manual should be followed carefully in order to meet the needs of various sections within the Department.

OBJECTIVE

The objective of this manual is to establish the methods used in gathering pavement surface distress data. These methods must be systematic, uniform, consistent, and repeatable. Moreover, the data gathered using these methods must collectively form a reliable tool for: determining pavement deficiencies, program planning, estimating remedial measures, studying investment alternatives, studying materials, scheduling maintenance, modelling distress, and design considerations.

SCOPE

Using the methods established in this Manual, pavement surface distress on Wisconsin's STH system may be assessed mathematically (i.e., may be rated). A PDI survey is performed biennially by the districts on the mainline of the entire STH system including municipal extensions . The exceptions to this statement of survey frequency are the Interstate Highways and all STH Continuously Reinforced Concrete Pavements (CRCP), both of which are surveyed on an annual basis by Pavement Management staff. Included in the PDI surveys are major distresses found by WisDOT to be suitable for assessing the condition of Wisconsin's Asphaltic Concrete (AC) and Portland Cement Concrete (PCC) pavements.

The pavement surface distress rating employs a sampling-type survey. To simplify the survey, the entire STH system is divided into sections. Each section is defined by the Reference Point (RP) system and is considered to be one nominal mile in length. A 10 percent (nominal) sample of each section is surveyed for pavement surface distress. This sample is generally referred to as the **survey segment**.

All pavements in the STH system fall into one of two groups, i.e., AC or PCC pavements. Each pavement type has a separate set of distress indicators. Asphaltic Concrete pavement has ten (10) distress indicators and Portland Cement Concrete[1] pavement has eleven (11) distress indicators.

PAVEMENT DISTRESS INDEX

The results of a pavement surface distress survey are used to calculate the Pavement Distress Index (PDI). PDI is a mathematical expression for pavement condition rating keyed to observable surface distresses. The PDI of a segment is a single number that summarizes the level of distress within the survey segment. PDI reflects the composite effects of various distress types and is used primarily for network-level evaluation with minor application to project-level analysis. (Note that at the project level, individual distress observations are of much greater value than PDI in determining present condition and treatment strategy.)

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[1] Continuously Reinforced Concrete Pavement (CRCP) is a subdivision of PCC. The section on CRCP explains the survey procedure and the additional distress indicators in this category.

The analysis procedure used to compute PDI accounts for the relative importance of the various distress indicators by assigning appropriate distress factors (weighting factors). PDI is used for ranking highway sections of similar pavement types and construction year. When used with the PSI, network level screening and assessment of pavement performance can be done.

INVENTORY SECTIONS

Identification

The identification of inventory sections relies on the Reference Point (RP) system established for the State Trunk Network (STN) highways. The rater must be familiar with the use of reference points and know how to use the STN Roadway Log. Information on the use of the RP system is available in Volumes 3 and 4 of the WisDOT Planning Manual.

For compatibility purposes, the PDI inventory sections are coincident with those established for PSI with the following exception. Although both PSI and PDI data are collected for Municipal Extensions[2], PDI data collection extends along connecting highways also. PDI inventory sections have therefore been established along these connecting highways.

Section termini correspond to RPs which are generally easily identified in the field and which may be close to changes in pavement age, type, etc. There are times, however, when section lines are used for RP's. In these cases, the rater should rely on mileage (as determined by a DMI or Distance Measuring Instrument) to locate section termini.

Lengths

Section lengths vary depending on the spacing of the reference points. Generally, sections are approximately one mile in length. However, section lengths between 0.4 and 2.0 miles are not uncommon. Present Serviceability and pavement surface distress surveys are conducted on all sections longer than 0.4 mile.

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[2] Municipal Extensions are STH's located within the corporate limits of cities or within village boundaries, excluding connecting highways. Municipal extensions terminate at construction limits where connecting highways then begin. Generally, the State has an agreement with the local unit of government that charges the local unit with maintaining the STH between these construction limits (i.e., on the connecting highway). Outside the construction limits the state's maintenance agreement is generally with the county. A listing of cities and villages having connecting highways along with the termini of these highways is available from Central Office Traffic.

Boundaries and Subsections

State Trunk Highways running along district boundaries (County lines) should be divided for survey purposes as mutually agreed upon between districts, e.g., the present split for maintenance purposes. When there is a change within a section in an important pavement characteristic such as pavement type, age, etc., the section should be treated as though it is composed entirely of the predominant pavement type, age, etc. Thus, the segment surveyed must lie within the predominant pavement type, age, etc.

INVENTORY FREQUENCY

The pavement distress inventory of the entire STH system is conducted once every two years. Half the counties in each district are surveyed each year during the same month(s) in spring. This reduces the effects of seasonal variations on the data collected. The biennial surveys should be conducted on the same segments surveyed previously. The Appendix provides details on how to establish survey segments.

GENERAL SURVEY PROCEDURE

Rating Team

All distress surveys require a two-man crew for both safety and efficiency of operation. During a distress survey, it is desirable for crew members to alternate tasks in order to reduce fatigue, boredom and subsequent errors. All distress survey crew members must be trained in distress rating procedures. To the extent possible, the same crew(s) in Pavement Management and in the Districts should be used to rate the pavements for distress each year. This requirement helps to keep the year-to-year variability introduced by inexperienced or untrained personnel to a minimum and ensures that the results are uniform and consistent.

Pavement Types

All pavement sections on the STH system are classified as belonging to one of two groups, AC or PCC pavement. This classification is based on the type of pavement that comprises the pavement surface. Thus, a roadmix, a hot-plant mix, and an asphaltic surface are all classified as AC. All PCC pavements regardless of whether they are plain, mesh reinforced, or continuously reinforced are classified as a PCC pavement.

Survey Location

To meet the sampling criterion, 10 percent of the entire STH system, one-tenth of a mile per section, is surveyed (see the definition of **survey segment** under Scope above). The one-tenth mile survey segment is generally the pavement segment from 0.3 - 0.4 mile from the beginning of the section. The beginning of the survey section is the location of the lowest RP when travelling in the cardinal direction.

If there is a change in pavement age, type, etc., within the section, then the one-tenth mile survey segment should be selected by the rater so that it falls within the major pavement age, type, etc., for that section. If the survey segment is near an interchange, relocate the segment so that it is beyond the end of the on-ramp or before the beginning of the exit-ramp taper. If the survey segment is on a structure, relocate the segment so that it ends at least 0.05 mile before the structure or so that it begins at least one-tenth mile beyond the structure.

Survey Speed

The surveys are conducted from a slow moving vehicle travelling at an average speed of 5 mph on the right shoulder of the highway. The rater may adjust the speed according to weather and pavement conditions, variability of surface quality, severity and density of cracking, and traffic conditions.

At least three stops are necessary to inspect and verify crack widths and measure faulting and rutting depth. More stops may be required for survey segments that are borderline distress cases. If the pavement surface is new, stopping may not be necessary. **It is recommended that the raters occasionally walk some distance of the segment to "self calibrate."** The actual distance to be walked should be determined by the rater based on how well the "in-vehicle" and walking observations correspond.

Roadway Elements Surveyed

The pavement condition rating is conducted on the mainline of the **entire** STH system including Municipal Extensions and Connecting Highways. For a two-lane highway, both lanes are surveyed in the survey segment. Each direction of a multi-lane highway is treated as a separate roadway. The survey procedure for evaluating a two lane highway should be used to survey two lanes in each direction of a multi-lane highway. For six- or more than six-lane divided highways, the survey segment is the outer two lanes (lanes 1 and 2) in each direction. In urban areas where there are four or more than four lanes (divided or undivided) but the two outer lanes are turning or parking lanes, only the main-travelled (inner) lanes should be surveyed.

Certain roadway elements are excluded from the distress survey: ramps, bridges and approach slabs, curbs and gutters, shoulders, turning lanes, parking lanes, truck lanes (climbing lanes), waysides, and any other locations not considered part of the mainline. The inner travelled lane(s) on six- or more than six-lane divided highways are excluded from the distress survey.

At the end of the surface distress survey segment, a PDI Inventory Form should be filled in. The raters should discuss and agree on a value to be entered into the Inventory Form for each distress. Each column of this form should be filled in with a representative value of all distress specific to the column's distress category and applicable to the entire survey segment. It is recommended that the form be filled in for each survey segment before the next segment is surveyed.

Twenty Five Percent Rule

Unless this manual instructs otherwise, if a higher severity level exists for over 25 percent of a distress, the higher value should be recorded. As an example, the upper print on page 39 shows a case in which the severity level of 3 exists for over 25 percent of the area affected by this distress, thus the severity is rated 3.

Equipment

The equipment required for a PDI inventory survey is listed below:

Vehicle equipped with a distance measuring device able to measure to the nearest one-hundredth (0.01) of a mile.

Rut Depth Gauge

6-ft Straight edge

Ruler

Clipboard

Pencils

String

Strobe Light

STN Log Book

Fault Gauge

Data Inventory Forms

Safety equipment (vest, caps, etc.)

Safety

The surface distress survey procedure does not require closing any traffic lanes. However, the procedure does require viewing the pavement at speeds much slower than the posted speed limits. Frequent stops along the shoulder may also be required. These activities can create unsafe traffic conditions. Raters must therefore, exercise caution when conducting PDI surveys. Vehicles used in performing the surveys should be equipped with flashing yellow beacons, and the raters themselves should wear WisDOT orange safety vests with reflective striping. Pavement surface distress evaluations should not be conducted within one day of a holiday -- either before or after. In certain urban situations, PDI surveys should be avoided during rush hour traffic.

DISTRESS INDICATORS

General

The Pavement Surface Distress Inventory employs ten (10) distress indicators for AC and eleven (11) for PCC, as shown below:

AC

1. Block and Alligator Cracking
2. Transverse Cracking
3. Longitudinal Cracking
4. Patching
5. Flushing
6. Edge Raveling
7. Surface Raveling
8. Rutting
9. Longitudinal Distortion
10. Transverse Distortion
11. Segregation
12. Seal Coat
13. Crack Filling

PCC (all types)

1. Slab Breakup
2. Distressed Transverse Joint/Cracks
3. Patching
4. Surface Distress
5. Longitudinal Joint Distress
6. Faulting
7. Rutting

Additional Distresses for CRCP

8. Wide Cracks
9. Punch Outs
10. Diagonal Cracking
11. Pavement Deterioration

Table 1. Pavement surface distresses. *The list above shows the various distress indicators associated with both AC and PCC pavement. Additional distresses for CRCP are also listed.*

The rating of most distress indicators requires identification of the specific distress(es) present and determination of the severity and extent of those distresses identified within the survey segment.

The body of text within this manual is organized as a series of subsections presenting detailed discussions of the distress indicators (or distresses) listed in Table 1 above. In each subsection, probable causes of the distress(es) are given and the rating criteria for these indicators are discussed. The subsections also provide detailed procedures for uniformly identifying and describing, in terms of severity and extent, the pavement surface distress indicators listed in Table 1.

The three Sections that follow describe pavement surface distress indicators and present guidelines for establishing severity and extent levels of these indicators for rigid PCC, rigid CRCP, and flexible AC pavements. Five levels of severity (0-4) and four levels of extent (0-3) are defined. The procedures for measuring the severity and extent of surface distress indicators must be clearly understood and rigorously adhered to in order to obtain consistent, repeatable and meaningful data.

With each pavement surface distress indicator, color photographs are included to help identify and rate the topic distress. Illustrations and examples are also provided to aid in surface distress identification and rating.

Detailed examples and supporting information on how to fill out the various surface distress rating forms and associated work-sheets are presented in Appendix J, page 164.

Questions[3] on PDI theory, practice and related subjects can be answered by contacting Pavement Management Staff (See list of names in the Appendix H, page 158).

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[3] The photographs were obtained during PDI district follow-up visits and field surveys conducted on highways throughout the state. The distress definitions were developed based on the nationally accepted use and the following publications:

1. *Wisconsin Pavement Surface Distress Inventory Manual*. 1983 First Printing, prepared by Steve Shober, and February, 1991 Revision.

2. *Standard Nomenclature and Definitions for Pavement Components and Deficiencies. Special Report 113*. Highway Research Board.

3. *Highway Pavement Distress Identification Manual for Highway Condition and Quality of Highway Construction Survey*. USDOT/FHA. March, 1979.

4. *Premature Distress of Asphaltic Concrete Pavements In Wisconsin*. Steve Shober, August, 1985.

5. *Concrete Pavement Rehabilitation Manual*. WisDOT. May, 1992.

6. *Segregation of Asphalt Mixtures- Causes, Identification and Cures*. RR 366-1F. November, 1986.

ASPHALTIC CONCRETE PAVEMENTS

DISTRESS INDICATORS

The following section present a detailed description of each distress indicator and the method for establishing severity and extent of the distress.

ASPHALTIC CONCRETE SURFACE DISTRESS

This section presents methods, procedures, techniques, descriptions and photographs required to perform a pavement surface distress survey for Asphaltic Concrete pavements. Pavement distress indicators are identified and described, and where possible, probable causes are presented. Severity and extent levels are also discussed under each distress indicator.

Asphaltic Concrete pavements is a general term that is used to represent the three major pavement categories:

1. AC/FB (Asphaltic Concrete pavement over Flexible Base)
2. ARM (Asphaltic Road Mix)
3. AC/RB (Asphaltic Concrete Pavement over Portland Cement Concrete layer directly under the surface. This pavement type is the result of resurfacing a concrete pavement with asphaltic concrete).

Pavement surface distresses include a wide variety of pavement defects. It is not practical to rate all the distress on any given road since this would involve a considerable amount of manpower. The data obtained from such an effort probably would not justify the amount of work required. Therefore, WisDOT has identified and categorized the major surface distress indicators in AC pavements to include the following:

Cracking :
- Block
- Alligator
- Transverse
- Longitudinal

Flushing

Raveling:
- Edge
- Surface

Patching

Rutting

Distortion:
- Transverse
- Longitudinal

Segregation

Seal Coat

Crack Filling

Photographs are included to aid in identification of distress and to help produce consistent and repeatable results. Guidelines for quantifying severity and extent levels of the individual distress indicators are also given. Severity and extent levels are given only for those distress indicators which require one or both. For details consult the Appendix.

All the distress indicator listed above are, except for Seal Coat, Crack Filling and Segregation, used in the computation of a PDI for the section. A detailed treatment of the PDI is provided in Appendix E. Seal Coat, Crack Filling and Segregation are used to provide additional information about the PDI to the design engineer. Space is provided for remarks on any unusual occurrences such as maintenance activities.

Segregation

Newly constructed or overlaid pavements may have no visible distress on the surface; however, the survey crew should observe such pavements for segregation. Segregation has been identified as one of the major causes of premature distress in asphaltic concrete pavements in Wisconsin. "*Premature distress of asphaltic concrete pavement is defined as any distress, which, because of its severity and/or extent, requires special maintenance or inclusion of the pavement in the improvement program within six years from the time of construction.*"[4]

Asphaltic surfaces exhibiting segregation contain areas which are open textured and generally do not meet normal density requirements. The open texture and low density allows moisture and air to penetrate the mixture, resulting in durability-related damage such as surface raveling and weathering.

Reports on Early Distress (RED) in many cases cite segregation as the reason for poor performance and reduction in life of AC pavements. Although Segregation is not currently a part of the PDI formula, segregation should be evaluated and rated with the same attention given to the other distress indicators. **The extent given for segregation below should be used as a guide in evaluating all asphaltic concrete highways for segregation.**

Segregation will be evaluated using the following extent rating criteria:

0 = No segregation
1 = 1 - 2 segregated areas per survey segment
2 = 3 or more segregated areas per survey segment

[4] See Reference number 4 on page 9 in the Introduction to this manual.

Crack Filling

Crack Filling is an indicator that is not in the PDI formula but affects the PDI value of the section by masking the severity of the cracks. Crack Filling does not affect the extent but affects cracks of severity levels 1 and 2. Severity level 3 cracks are not affected by crack filling. Adequately filled cracks (except severity level 3 cracks) do not show crack distress. The resulting distress rating for a section may show a lower PDI than the previous PDI value indicating that the pavement "HEALED" between survey periods. The lower PDI value for the section is due to sealed cracks of severity level 1 and 2 having less weighting factors than severity level 3 cracks. Sealed and adequately filled cracks should be rated as severity 1, unless one can tell that the cracks are severity level 2 or 3.

Seal Coat

Seal coating AC pavements hides the surface distress and in effect lowers the PDI. **Indicate in the Seal Coat column (1=yes) that a seal coat is recent if no distress is apparent. Unless the Seal Coat masks the distress completely, do not rate it as existing. A seal coated surface that shows distress should always be rated as zero, i.e., no seal coat.** It is recommended that "Remarks" be used while surveying roadways for surface distress. The documented information is valuable for selecting the most appropriate rehabilitation strategy.

Block/Alligator Cracking

Block and Alligator cracking are treated separately in order to provide a more detailed explanation and hence increase clarification and understanding. Block and Alligator cracking are rated separately also. The predominant type of cracking by surface area should be rated. The entry in the inventory data sheet should reflect the type of distress rated by indicating either an entry of "1" or "2". The column marked **"1=Block, 2=Alligator" must be filled.**

Illustrations of typical Asphaltic Concrete pavement distress are provided to show the general rating procedure, including measurement and estimation techniques. Figure A1 below illustrates typical patterns that will be encountered in evaluating Block, Alligator, Transverse, Longitudinal Cracking, Patching, and Edge Raveling in AC pavements. It is recommended that illustrations such as Figure A1 below be used in conjunction with the photographs of actual distress to obtain consistency and repeatability in evaluating pavement surface distress.

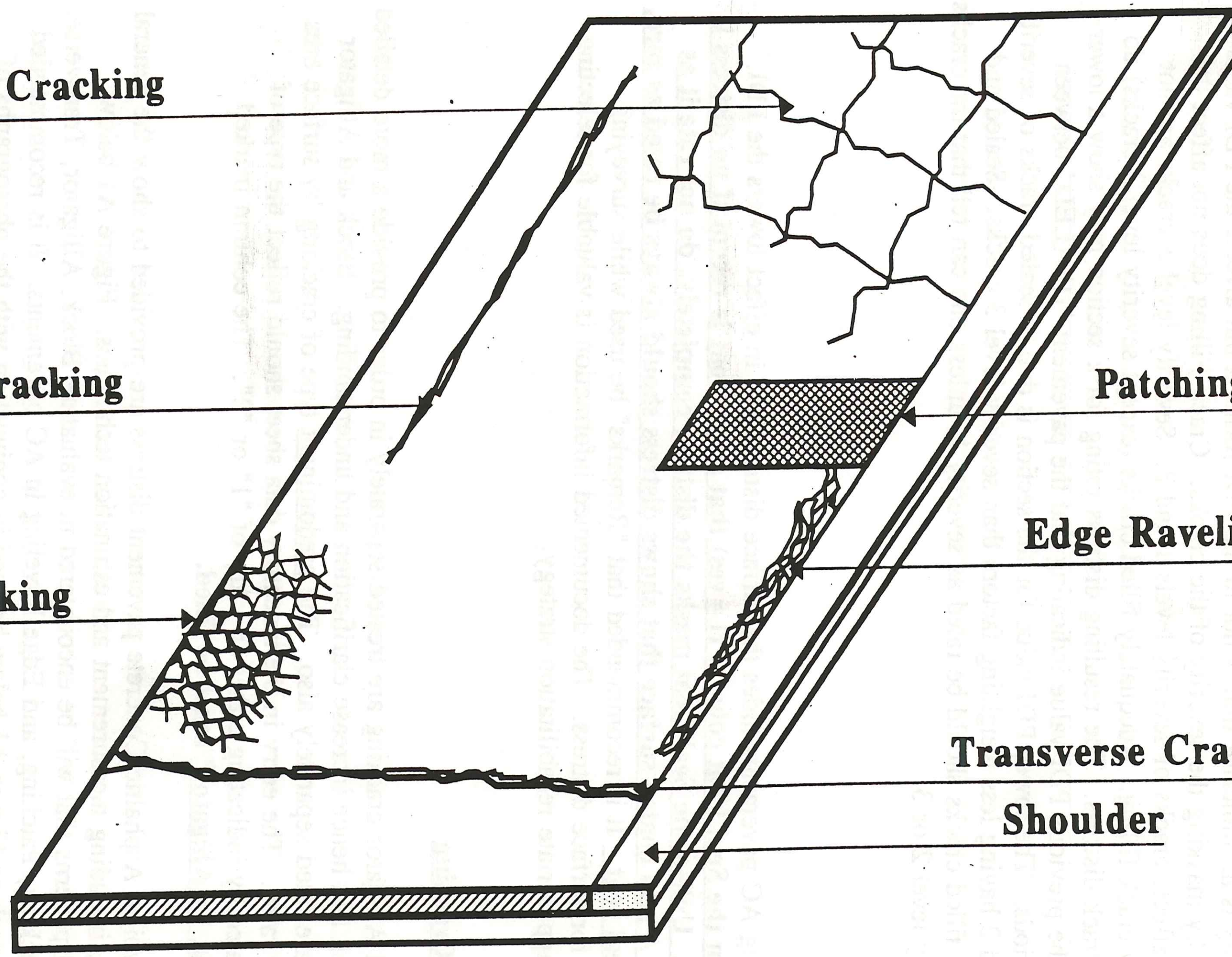

Figure A1. Typical Distress indicators in AC Pavements

Shoving, Waves, Settlement, Heaving, and Tenting are rated under Longitudinal Distortions. Potholes are possible patches and should be rated as patches. Edge Tipping and edge Rolldown constitute Transverse distortions.

ALLIGATOR CRACKING

Description: Alligator cracking is the interconnecting of cracks forming a series of small polygons that resemble an alligator's hide or chicken wire.

Cause: Alligator cracking[5] is generally caused by an unstable base or road bed. The cracks start at the bottom of the asphalt surface and propagate to the surface as longitudinal cracks. As traffic loading continues, the cracks form many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are usually less than one (1) foot on the side.

1 = Block Cracking
2 = Alligator Cracking

Severity

The main difficulty in measuring alligator cracking is that in many cases more than one type of distress exists at any given time and at varying levels of extent and severity. The predominant type of cracking (by surface area) should be rated.

0 = None

1 = cracks less than 1/2-inch in width (cracks are not spalled).

2 = cracks greater than 1/2-inch in width (some loss of aggregate particles).

3 = cracks causing dislodgement of a significant number of pavement pieces.

Extent

The extent of alligator cracking is based on the percentage of the surface area of the survey segment. Alligator cracking is measured[6] in square feet of surface area.

0 = None	3 = 50 to 74%
1 = 10 to 24%	4 = 75% +
2 = 25 to 49%	

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[5] ***Alligator cracking occurs only in areas that are subjected to repeated traffic loadings. Cracking which occurs in an area that is not subject to traffic loading should be rated as block cracking. Alligator cracking is a major structural distress.***

[6] ***If a segment has 26% Alligator Cracking, and 20% Block cracking, rate as Alligator Cracking. However, if the segment has 100% Alligator cracking, rate as Alligator cracking only (do not rate other distresses). In all cases of overlapping distress types, rate the worst.***

ALLIGATOR CRACKING

Figure A2.

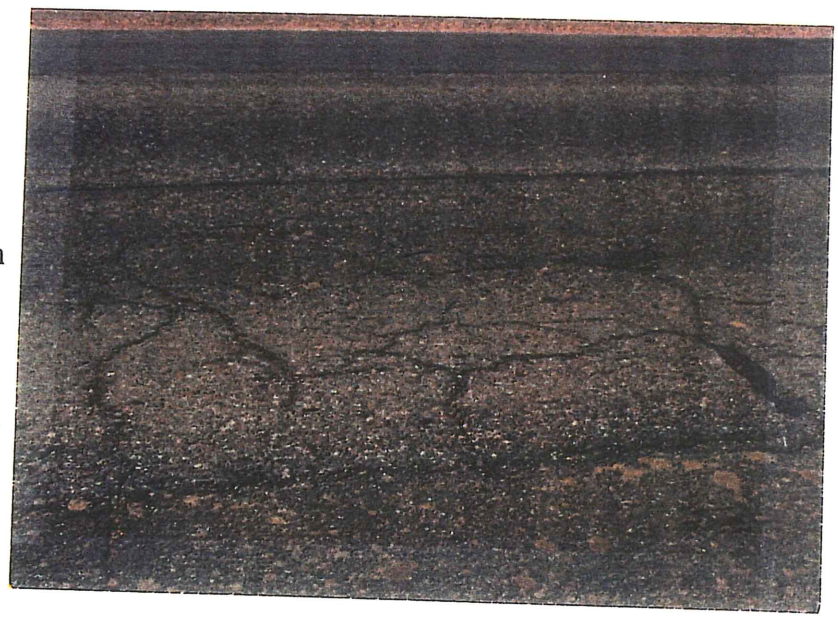
Severity = 1 Extent = 4

The print on the left shows Alligator cracks that are less than 1/2-inch in width. Extent = 4 if the condition exists for over 75% of the segment.

Figure A3.

Severity = 1

Extent can not be determined from the photo. The blocks are beginning to form a series of smaller polygons resembling chicken wire.



ALLIGATOR CRACKING

Figure A4.

Severity = 2 Extent = 4
(as shown in this print)

Alligator cracking over the entire area. This is typical of insufficient road bed support.

Figure A5.

Severity = 3 Extent = 4

The print on the right shows a severe case of Alligator cracking. Over 75 % of the pavement surface has Alligator cracking. Also, a significant amount of the surface has been dislodged.

BLOCK CRACKING

Description: Block cracking is the interconnecting of cracks forming a series of large polygons usually with sharp corners or angles.

Cause: Block cracking is generally caused by hardening and shrinkage of asphalt pavement. Block cracking is distinguished from other forms of cracking by pavement age, cause, and appearance and normally does not develop until late in the pavement's life.

Generally Block cracking does not occur in Asphaltic pavements over Portland Cement Concrete. When Transverse cracks are intersected by a longitudinal crack, e.g., two transverse reflective cracks intersected by the longitudinal crack over an edge widening, the blocks thus formed are <u>not</u> block cracking.

4'-6' Between Trans. Cracks
usually 2 clicks or less

1 = Block Cracking
2 = Alligator Cracking

Severity

0 = None

1 = cracks less than 1/2-inch in width

2 = cracks greater than 1/2-inch in width (some loss of aggregate particles).

3 = cracks causing dislodgement of a significant number of pavement pieces.

Extent

The extent is based on the percentage of the area of the survey segment affected. Total[7] area of the pavement surface affected is measured in square feet of surface area.

0 = None
1 = 10 to 24%
2 = 25 to 49%
3 = 50 to 74%
4 = 75% +

[7] *Block cracking occurs at one severity level within a given pavement section. However, the extent may differ from area to area. If an area of the pavement section exhibit different levels of severity, the 25% Rule (see page 7) should be applied to determine the appropriate severity level for the segment.*

BLOCK CRACKING

[illegible] Block cracking is [illegible] cracking [illegible] usually with [illegible] angles.

[illegible] pavement. Block cracking is distinguished from other forms of cracking [illegible] appear [illegible]

[illegible] cracking does not occur [illegible] asphaltic pavements [illegible] Where transverse cracks are intersected by a longitudinal crack, e.g., two transverse [illegible] by one longitudinal crack over an entire width, the [illegible] pattern are not block cracking.

[illegible] Block Cracking
[illegible] Cracking

Severity

0 [illegible] None

1 [illegible] less than 1/2-inch [illegible] width

2 [illegible] greater than 1/2-inch in width (some loss of aggregate [illegible])

3 [illegible] dislodgement of a significant number of pavement pieces

Extent

[illegible] Extent is based on the percentage of the area of the survey segment affected. [illegible] total area of the pavement surface affected is measured in square feet of surface area.

[illegible] = [illegible] to 74%
[illegible] = 10 to 24% [illegible] = [illegible] 5% [illegible]
[illegible] = 25 to 49%

[illegible] Block cracking [illegible] within a [illegible] the area of the [illegible] different levels of severity, the [illegible] rule [illegible] should be applied to determine the appropriate severity level for the segment.

BLOCK CRACKING

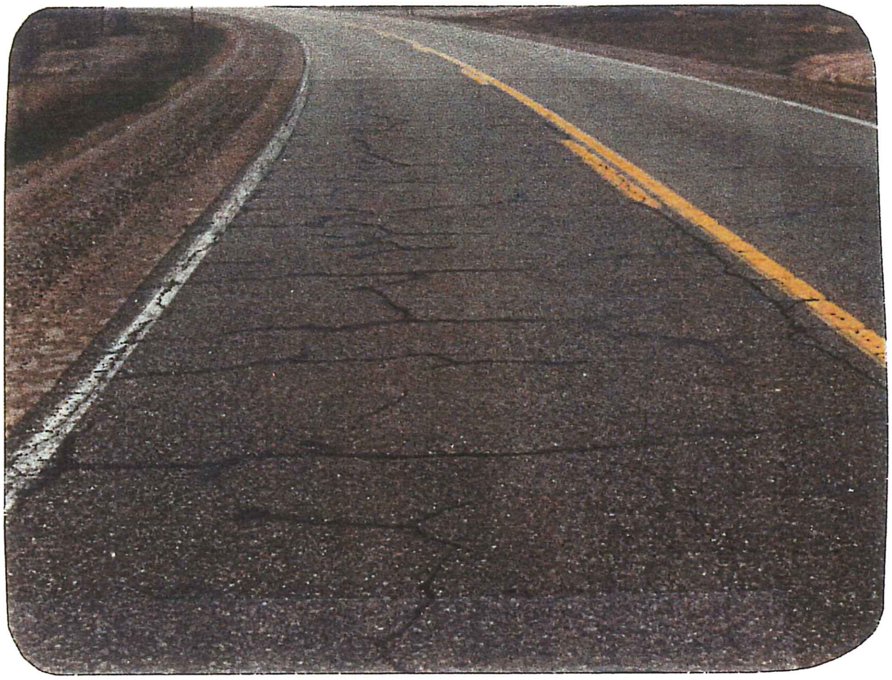


Figure A6.

Severity = 1 Extent = 4
Typical cracking over entire pavement surface.

Figure A7.

Severity = 2 Extent = 4

Photo on the right shows a section of the survey segment with block cracking over entire pavement surface area.

BLOCK CRACKING

Figure A8.

Severity = 2 Extent = 4

Block Cracking over the entire segment area.

Figure A9.

Severity = 2 Extent = 4

Typical block cracking over entire pavement surface.

TRANSVERSE CRACKING

Definition: A crack running approximately at right angles to the centerline.

Cause: May be caused by shrinkage of the AC surface or by reflective cracks propagating upward from cracks running beneath the surface course. Cracks/Joints in underlying rigid pavements reflect to the pavement surface and cause transverse cracks.

Severity

0 = None

1 = less than 1/2-inch in width

2 = greater than 1/2-inch in width

3 = band cracking (multiple cracks in close proximity resulting in a narrow band of cracks) with or without dislodgement. A transverse crack is banded if the pavement area affected is within one (1 ft.) of the crack. Cracks beyond this limit are considered as either Block or Alligator cracking.

Hairline cracks are rated as category 1 cracks. Cracks that have been sealed and cracks that have been filled but have recracked will be included in the severity and extent ratings. <u>Sealed and adequately filled cracks should be rated as severity level 1 unless one can tell that the cracks are severity level [redacted] "3".</u> All other cracks should be rated by severity and extent according to existing crack opening as detailed in this manual.

Extent

The extent of Transverse Cracking is determined from the average number of transverse cracks per station in the survey segment. A transverse crack should be six (6) feet in length to be counted.

0 = None
1 = 1 to 5 cracks per station
2 = 6 to 10 cracks per station
3 = greater than 10 cracks per station

TRANSVERSE CRACKING

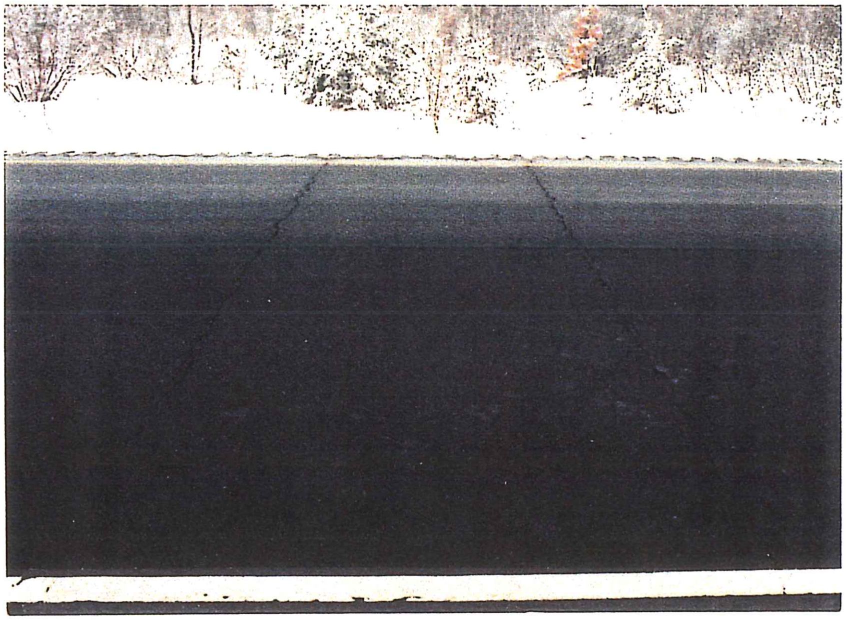


Figure A10.

Severity = 1 Extent = 1

The transverse cracks are generally less than 1/2-inch in width with minor spalling at the crack edges.

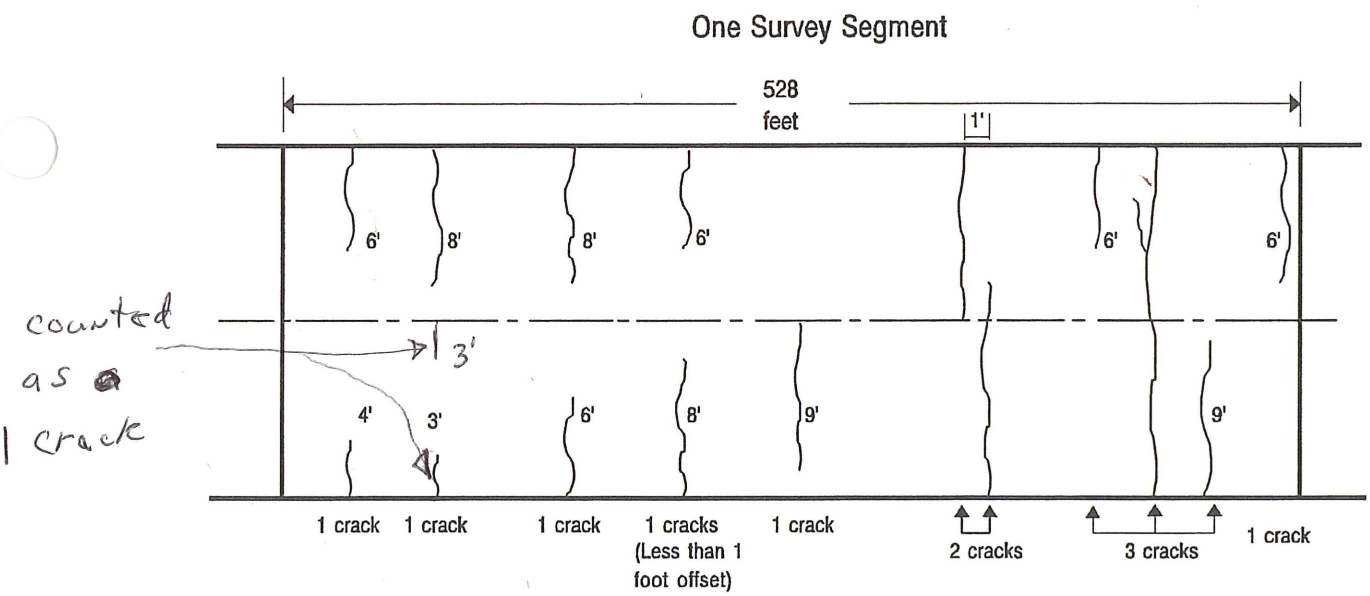


Figure A11. Transverse Cracking

Example. The schematic drawing above represents two lane of AC pavement, one tenth mile long. Various crack patterns are shown to illustrate how to count transverse cracks. The total number of cracks in 5 stations is 11; Extent = 1.

TRANSVERSE CRACKING

Figure A12.

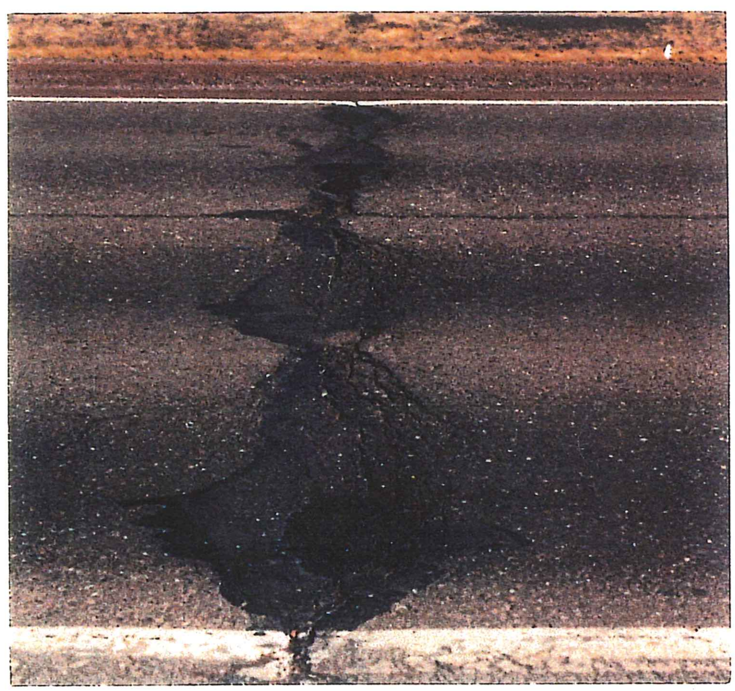
Severity = 3 Extent = 1

The crack width is greater than 1/2-inch. Some dislodgement is apparent. The severity of the crack in this photograph is between 2 and 3.

Figure A13.

Severity = 3, Extent = 1

These transverse cracks are greater than 1/2-inch in width and severely banded. Crack filling does not stop raveling and particle dislodgement.



LONGITUDINAL CRACKING

Definition: A crack running approximately parallel to the centerline of the roadway.

Causes: May be caused by a poorly constructed paving lane joint, shrinkage of the AC surface due to low temperatures or hardening of the AC. Reflective cracking due to cracks or joints beneath the surface course may also cause longitudinal cracking.

Severity

The rules for determining severity are similar to those used for transverse cracks.

0 = None

1 = less than 1/2-inch in width

2 = greater than 1/2-inch in width

3 = band cracking (multiple cracks in close proximity resulting in a narrow band of cracks) with or without dislodgement. A Longitudinal crack is banded if the pavement area affected is within one (1 ft.) of the crack. Cracks beyond this limit are considered as either Block or Alligator cracking.

Hairline cracks are rated as category 1 cracks. Cracks that have been sealed and cracks that have been filled but have recracked should be included in the severity and extent ratings. Sealed and adequately filled cracks should be rated as severity level 1 unless one can tell that they are severity level "2" or "3". All other cracks should be rated by severity and extent according to the existing crack opening as detailed in this manual.

Extent

The extent of longitudinal cracking is determined from the average lineal foot of cracks in both lanes per station.

0 = None
1 = 1 to 100 feet per station
2 = 101 to 200 feet per station
3 = 201 to 300 feet per station
4 = greater than 300 feet per station

LONGITUDINAL CRACKING

Figure A14.

Severity = 1, Extent = 2

These longitudinal cracks appear to be filled and have not re-opened. There is less than 200 feet of longitudinal cracking per station.

Figure A15.

Severity = 2, Extent = 1

The longitudinal crack on the right is greater than 1/2-inch in width and has minor banding for less than 25% of its length.

LONGITUDINAL CRACKING

Figure A16.

Severity = 3, Extent = 2
These longitudinal cracks are banded and are between 101-200 feet per station.

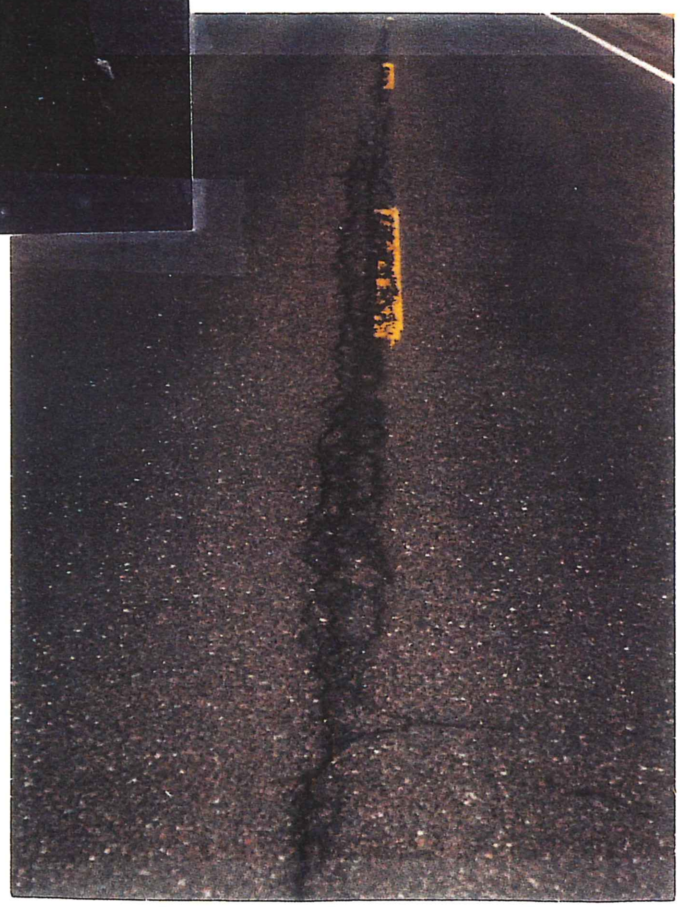


Figure A17.

Severity = 3, Extent = 1

There is band cracking at the centerline joint, and there appears to be 100 feet of such cracking per station.

LONGITUDINAL CRACKING

Figure A18.

Severity = 3, Extent = 1

There is band cracking at the centerline joint and there appears to be 100 feet of longitudinal cracking per station.

Figure A19.

Severity = 3, Extent = 3

There is band cracking at the centerline joint, and there appears to be 201-300 feet of longitudinal cracking per station.

PATCHING

Definition. Patching is the replacement of original pavement material with Asphaltic concrete pavement. Patches may be either a temporary or a permanent correction to a section of damaged pavement. Potholes[8] are considered to be future patches and are therefore rated as patches. Wedging and rut filling should also be rated as patches.

Other distress types occurring in the patched areas of the pavement are rated as patching distress. Distressed patches may show disintegration, distortion, cracking, spalling or delamination.

Severity

The severity level of patching should be rated according to both patch deterioration and patch performance (how well does the patch serve traffic).

0 = no patching

1 = Patch in good condition and performing satisfactorily

2 = Patch in fair condition but somewhat deteriorated and affects ride quality to some extent

3 = Patch in poor condition. Ride quality is significantly affected.

Extent

Patching extent is based on the percent of the length of the survey segment.

0 = None

1 = occasional small patch

2 = less than 10%

3 = 10 to 25%

4 = greater than 25%

---

8 *Potholes are bowl-shaped holes of various sizes in the pavement surface.*

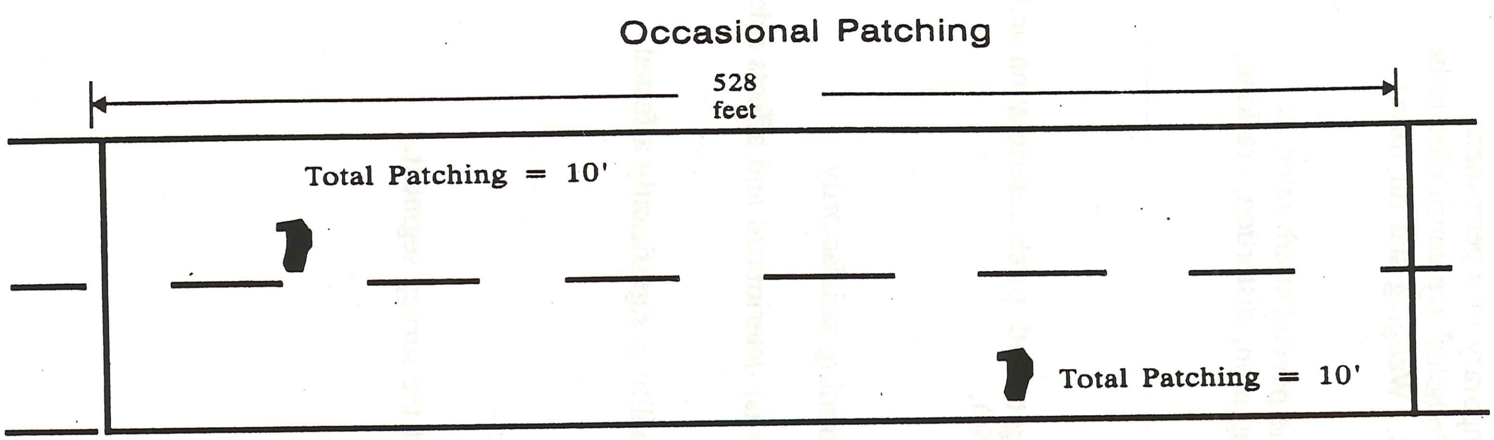


Figure A20. Patching

Example 1. The total patching for the segment is 20 feet. The extent of patching is occasional, i.e., Extent = 1.

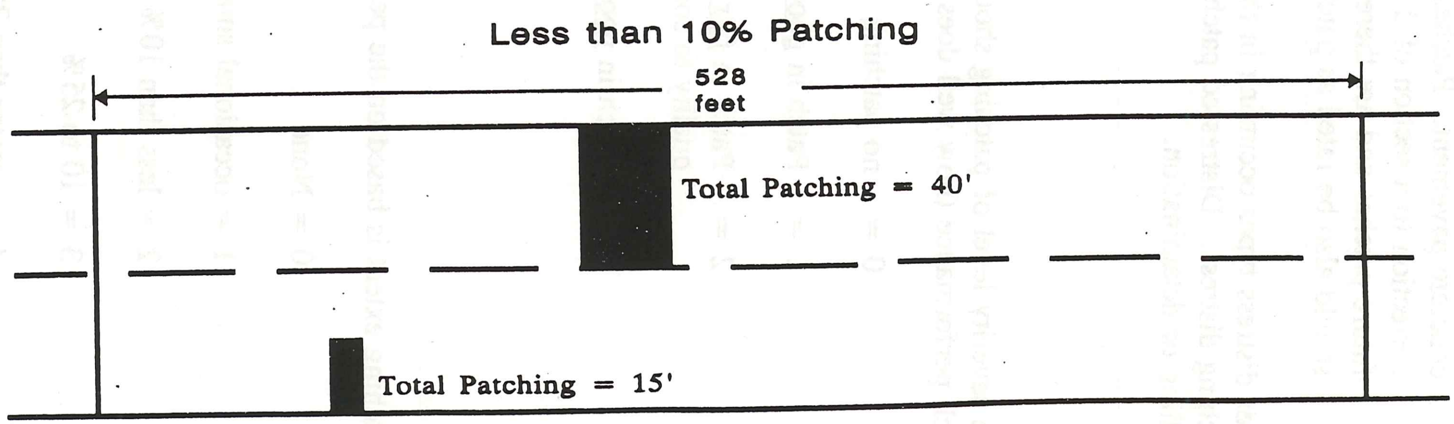


Figure A21. Patching

Example 2. Total patching for the segment is (40+15) = 55 feet The Extent of patching is less than 10%; Extent = 2.

Ten to twenty five Percent Patching

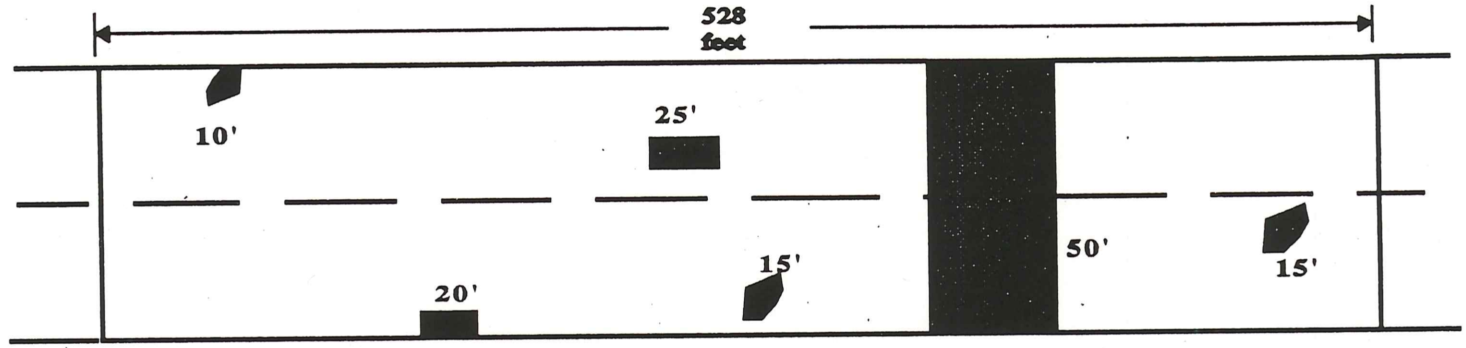


Figure A22. Patching

Example 3. The total patching for the segment is (10 + 25 + 20 + 15 + 50 + 15) = 115 feet. The extent of patching is between ten and twenty five percent, i.e., Extent = 3.

Greater than 25% Patching

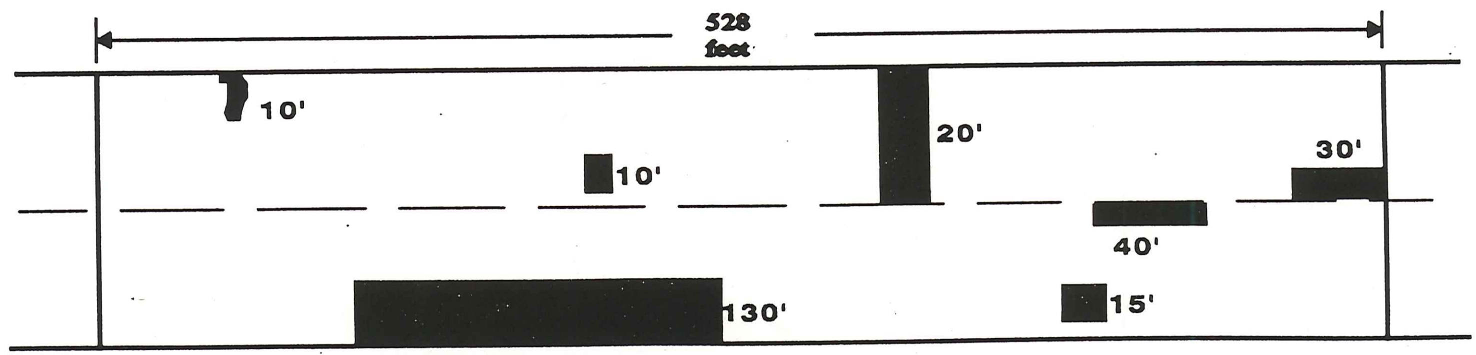


Figure A23. Patching

Example 4. The total patching for the segment is (10 + 20 + 30 + 10 + + 130 + 15 + 40) = 255feet. The extent of patching is Greater than twenty five percent, i.e., Extent = 4.

PATCHING

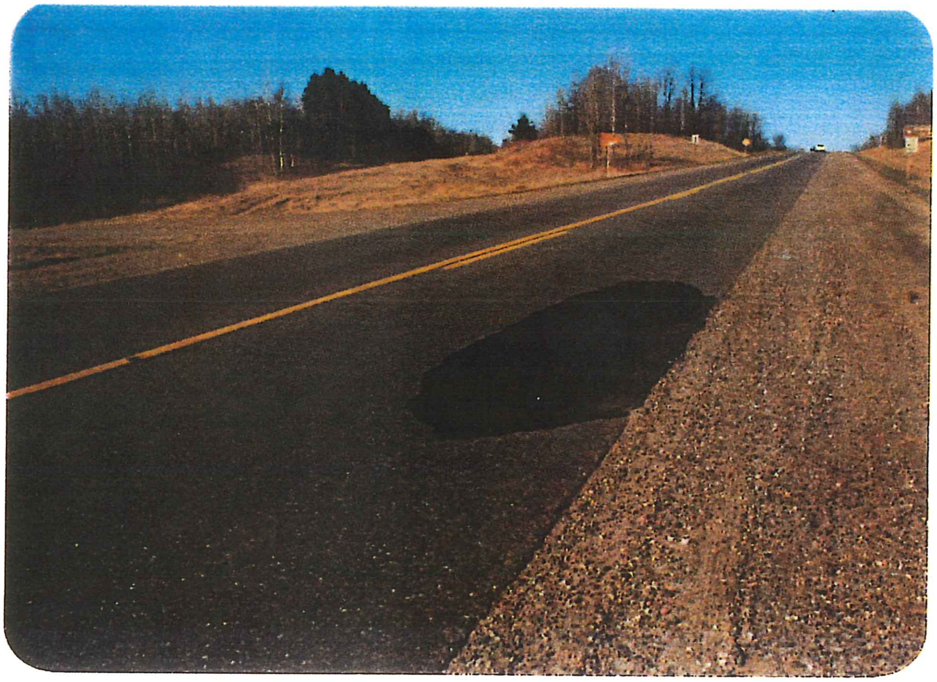


Figure A24.

Severity = 1, Extent = 1

Occasional small patches in good condition. Ride quality is not affected by the number of patches.

Figure A25.

Severity = 2 Extent = 1

The patch on the right is in fair condition. It is somewhat deteriorated and affects ride quality to some extent.

PATCHING

Figure A26.

Severity = 3 Extent = 4

These patches are in poor condition and affect more than 25% of the length of the segment. Ride quality is significantly affected.

Figure A27.

Severity = 3 Extent = 4

These patches also significantly affect the ride. They are in very poor condition and seem to affect over 25% of the length of the segment.

FLUSHING

Definition. The term Flushing (bleeding) refers to a film of Asphaltic material on the pavement surface which creates a shiny, greasy, smooth, reflective surface.

Causes. Flushing is caused by excessive amounts of asphalt cement in the mix, low air void content or insufficient blotter. Flushing occurs when the asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement.

Flushing should be rated if the aggregate on a seal coated roadway wears off or disappears and exposes the asphalt.

Severity Rating

Flushing is assigned a severity level only.

0 = Flushing is not present or occurs only in small isolated areas.

1 = Flushing is present but not sufficient in severity to affect traffic safety significantly.

2 = Flushing[9] is present for a significant portion of the survey segment and is severe enough to cause a significant reduction in pavement surface friction and presents a potential problem.

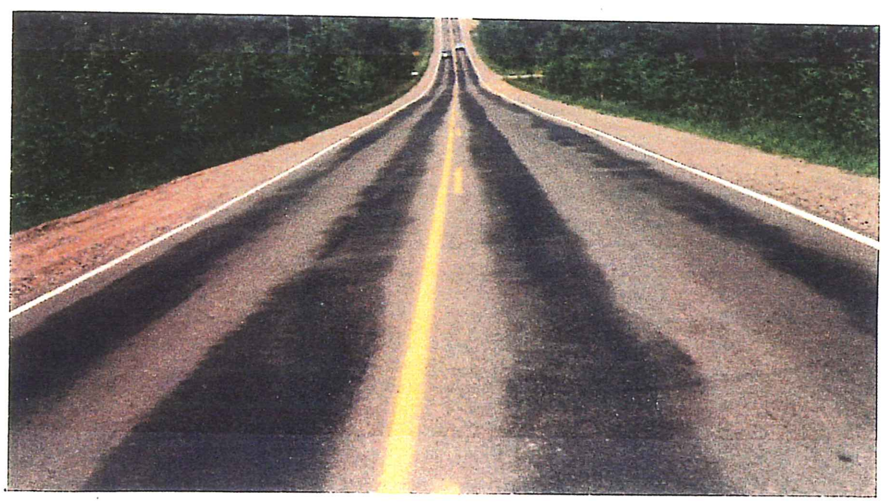


Figure A28.

Severity = 2

The print on the left shows significant amount of flushing in both wheel-paths.

9 *Note: Flushing in one wheel path can be as dangerous as in both wheel paths because it can cause the vehicle to spin during a braking maneuver. This level of flushing does not have to exist over the entire segment. A field review of this area is recommended; please document the results of the field review in the Remarks row on the data sheets.*

FLUSHING

Figure A29.

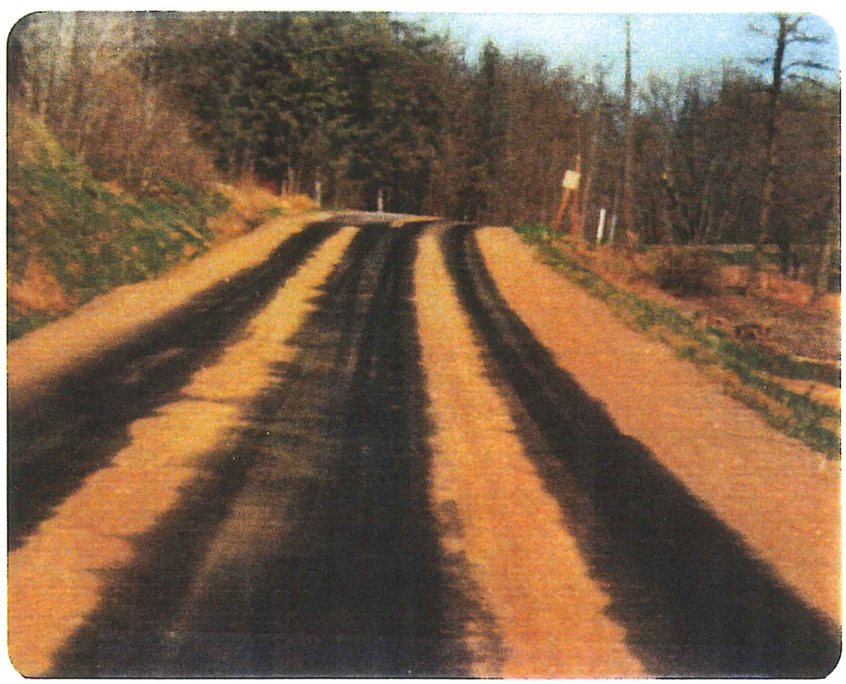
Severity = 1

The print on the left shows a case bordering between ratings of zero and one. Flushing occurs only in one lane. In borderline situations, the higher level of severity should be used to rate Flushing.

Figure A30.

Severity = 2.

The photo on the right is a case where there is significant amount of flushing in both wheel paths.



EDGE RAVELING

Definition. Edge Raveling is used by Wisconsin DOT to describe the breakup of the edge of the pavement. The pavement surface considered under this category extends from the outer pavement edge-line marking to a distance one-foot inside the travelled way.

Causes. Edge Raveling is caused by a lack of vertical or lateral support, an unstable mix, or the effects of traffic loads.

Most roadways have paved shoulders. If the raveling is not within one-foot (on the traffic side) of the pavement edge-line marking, Edge Raveling should be rated Zero(0), indicating no distress present.

Severity Rating

Edge Raveling is assigned severity levels only. Edge Raveling is given a rating other than zero if the condition exists for over 10 percent of the pavement length (on either side of the roadway).

0 = distress not present (Edge raveling present, but < 10% of Segment length)

1 = visible cracking (slight)

2 = some dislodgement (moderate)

3 = breaking away and dislodgement of a significant quantity of the pavement (severe)

EDGE RAVELING

Figure A31.

Severity = 2

The photo on the left shows moderate cracking with some pavement dislodgement.

Figure A32.

Severity = 3

A large amount of pavement has been dislodged along the edge which is receding due to material loss.

SURFACE RAVELING

Definition. Surface Raveling and Weathering, though distinctive in cause and appearance, are similar enough to group together. Raveling is the progressive downward disintegration of the surface by the dislodgement of aggregate particles.

Weathering (sanding) is the gradual disintegration of the pavement wearing surface, increasing the texture and continuously exposing more and more coarse aggregate.

Causes. **Raveling:** Raveling is caused by insufficient asphalt content or bonding agent in the surface or by the action of traffic on a weak surface. Raveling may also occur as a result of asphalt binder aging, poor quality of mixture, segregation or insufficient compaction.

Weathering: Weathering is due to the oxidation and hardening of the mix caused by climatic conditions.

The rating of Surface Raveling and Weathering primarily considers dense graded AC surfaces. Open graded surfaces, chip seals, and other surface treatments inherently possessing a coarse texture are not easily rated. Extra care must be taken to assure that the "**correct**" rating is obtained. **A seal coated surface should be rated for raveling if the aggregate loss goes down into the original pavement surface.**

Severity Rating

Surface Raveling is assigned severity levels only. The rating of surface raveling is not affected by the location of the distress on the roadway pavement surface. However, attention should be given to the amount of surface raveling within the survey segment.

0 = distress not present

1 = the aggregate and/or asphalt binder has worn away and the surface texture is slightly rough or pitted.

2 = same as 1 above except the surface texture is moderately rough or pitted.

3 = same as 1 above except the surface texture is severely rough or pitted

SURFACE RAVELING

Figure A33.

Severity = 1

Beginning stages of raveling where few coarse aggregate particles are dislodged. Aggregate binder has started to wear away; the distress is uniformly distributed over entire lane width.

Figure A34.

Severity = 2

Aggregate and/or binder has worn away, and the surface texture is moderately rough and pitted. Loose particles can be seen. The distress is confined in the wheel tracks.

SURFACE RAVELING

Figure A35.

Severity = 3

Raveling and weathering combined on the pavement on the left to give a severity level of 3 in the wheel path and a 2 between the wheel paths. Since severity level 3 exists for over 25% of the segment, the severity would be rated as 3.

Figure A36.

Severity = 3

The photo on the right shows a case where the wheel path has been patched to fill the pitted surface. The outer wheel track has Surface Raveling at severity level 3, and the inner wheel path has severity level 2. Severity level 3 exists for over 25% of the segment. The severity is rated as 3.

SURFACE RAVELING

Figure A37.

Severity = 3

A close look at the surface of this pavement indicates that aggregate particles are dislodged. The surface texture is severely pitted.

RUTTING

Definition. Rutting is a longitudinal depression in the wheel paths. Rutting comes from permanent deformations in the pavement layers or subgrade.

Causes. Rutting is caused by an unstable pavement or foundation. Heavier traffic than the design strength of the pavement structure may cause consolidation or lateral movement of the material resulting in rutting.

At least three rut measurements made no less than five feet from a transverse crack and no less than 3 feet from the roadway center line (inside), should be made for each survey segment. The severity rating for each segment will be the average of the three or more measurements. Measurements made at least five feet from transverse cracks avoid the excessive distortion which is frequently present near these cracks. In severe cases, pavement uplift may occur along the sides of the rut, but in most cases, only <u>wheel-path depression</u>[10] is noticeable. Rut measurements should be made at locations where maximum rut depths occur.

Severity Rating

Rutting is assigned severity levels only. The extent is assumed to be 100 percent of the segment. The four severity levels are:

0 = rutting not represent or insignificant in amount

1 = rutting 1/4- to 1/2-inch in depth

2 = rutting 1/2- to 1 inch in depth

3 = rutting greater than 1 inch in depth

---

10 ***Wheel-path depressions (ruts) are not considered as transverse distortion. However, it is possible that rutting can cause transverse distortion outside the wheel paths. If there is more than 1/2-inch difference in the rut depth between the inner and outer wheel path, and the rutting in the outer wheel-path is greater than one inch, then Transverse distortion should also be rated.***

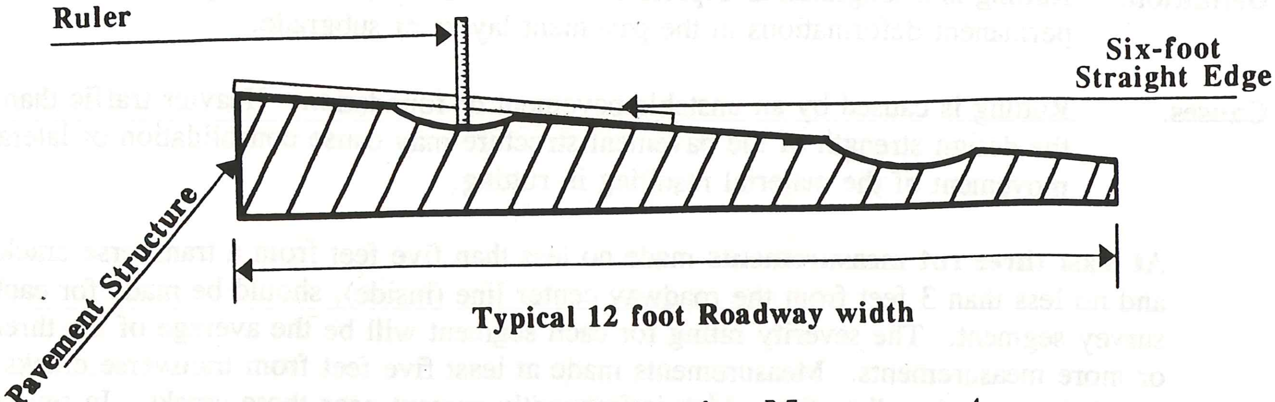


Figure A38. Rutting Measurement

Figure A38 illustrates rutting in a typical 12 foot lane width. Rutting is measured in the inner wheel path, i.e., 3 feet from the center line. If there is more than 1/2-inch difference in the rut depth between the inner wheel-path and the outer wheel-path, and the rutting in the outer wheel-path is greater than 1 inch, Transverse Distortion should be rated also.

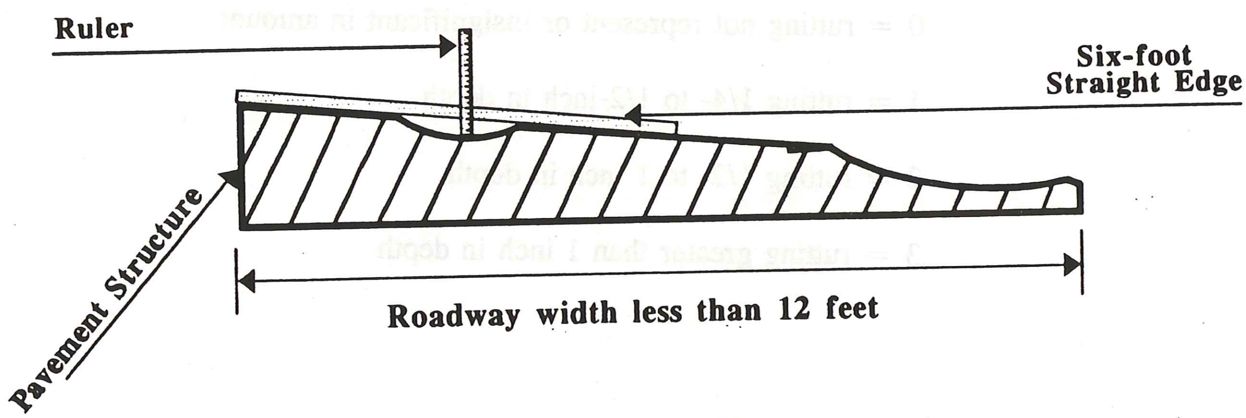


Figure A39. Rutting Measurement

Rut Measurement for roadway widths less than 12 feet is conducted as explained in Figure A38 above. Any Edge Tip-up or Roll-down should be rated as Transverse Distortion.

RUTTING

Figure A40.

Severity = 1

Rut measurements can be taken using a string as shown in the print on the left. Rutting is between 1/4-and 1/2-inch in depth.

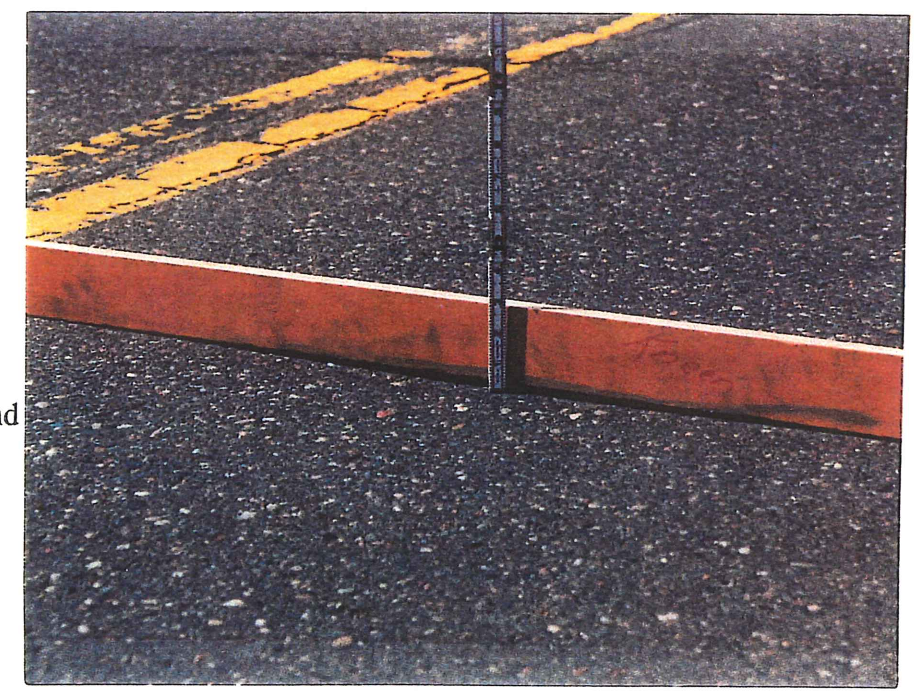


Figure A41.

Severity = 1

Measurement in the print on the right were done using a straight edge. Rutting is between 1/4 and 1/2-inch in depth.

RUTTING

Figure A42.

Severity = 2

Rutting is between 1/2-inch and 1 inch in depth.

Figure A43.

Severity = 3

Rutting greater than 1 inch in depth. Rut depth in the print on the right is slightly greater than one inch. Severity level 3 is the correct rating.

RUTTING

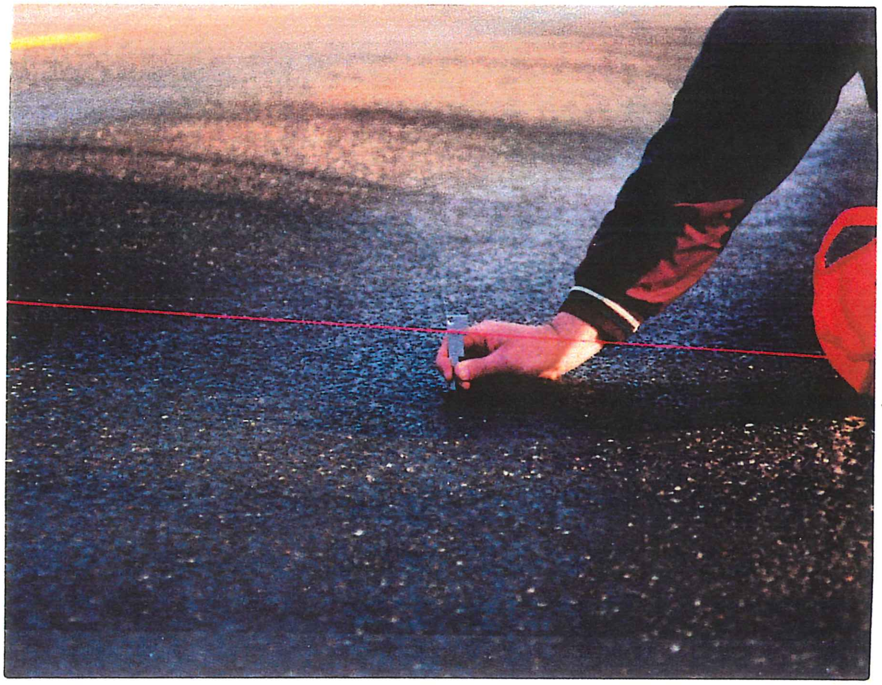


Figure A44.

Severity = 3

Rutting greater than one inch in depth. Rutting on the inner and outer wheel path should be measured to determine if transverse distortion should be rated.

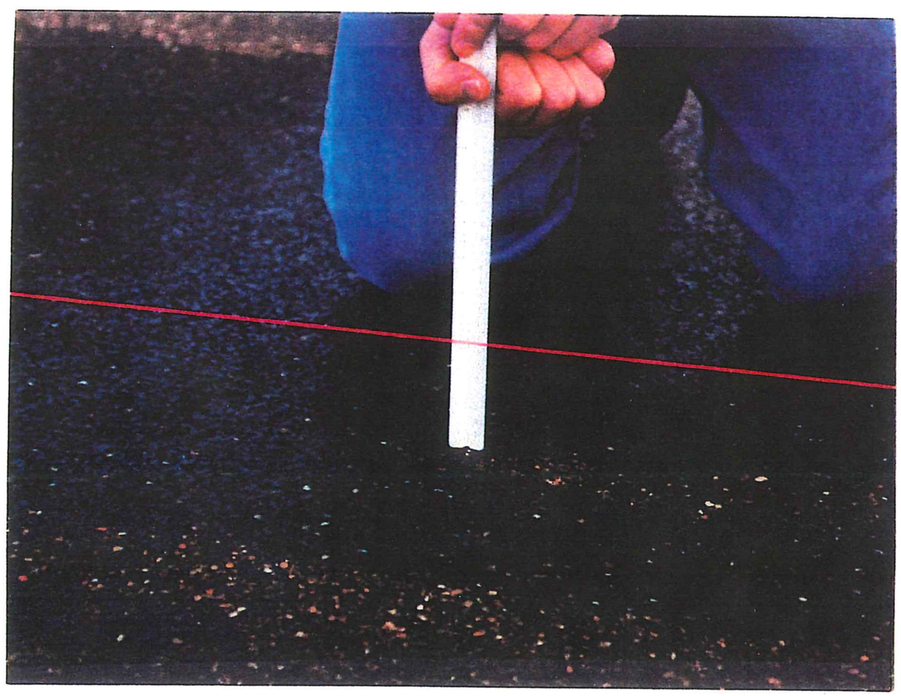


Figure A45.

Severity = 3

Rutting in this photo is greater than 1 inch in depth. Measure rutting in the outer wheel-path to determine whether transverse distortion should be rated (see footnote on page 41).

LONGITUDINAL DISTORTION

Definition. A distress category that incorporates all those pavement distresses resulting in, or the result of, a change in the intended **longitudinal profile** of the pavement. Typical distresses in this category are:

Shoving: Displacement or bulging of paving material in the direction of loading or pressure. Corrugation (a series of transverse ridges and valleys occurring at regular intervals, generally less than two feet apart, along the pavement) is a typical form of shoving. Unstable asphalt mixture, poor base quality or improper mix design are associated with this distress.

Waves: Transverse undulations in the surface of the pavement consisting of alternating valleys and crests generally two, or more, feet apart.

Settlement: A dip in the longitudinal profile of the pavement surface. A condition in which a portion of the pavement has settled or has become depressed in relation to the intended profile.

Heaving: A condition in which a portion of the pavement has been elevated with relation to the intended profile.

Tenting[11]: A cold weather condition resulting in raising of the pavement near a joint or crack.

Severity

0 = none or insignificant

1 = yes, it exists to a significant degree

Extent

The extent of distortion will be rated according to the percentage of the length of the segment.

0 = none

1 = 1 - 24%

2 = 25 - 49%

3 = greater than 50%

---

11 **If every crack within the segment is affected by tenting or settlement the extent would be 3.**

LONGITUDINAL DISTORTION

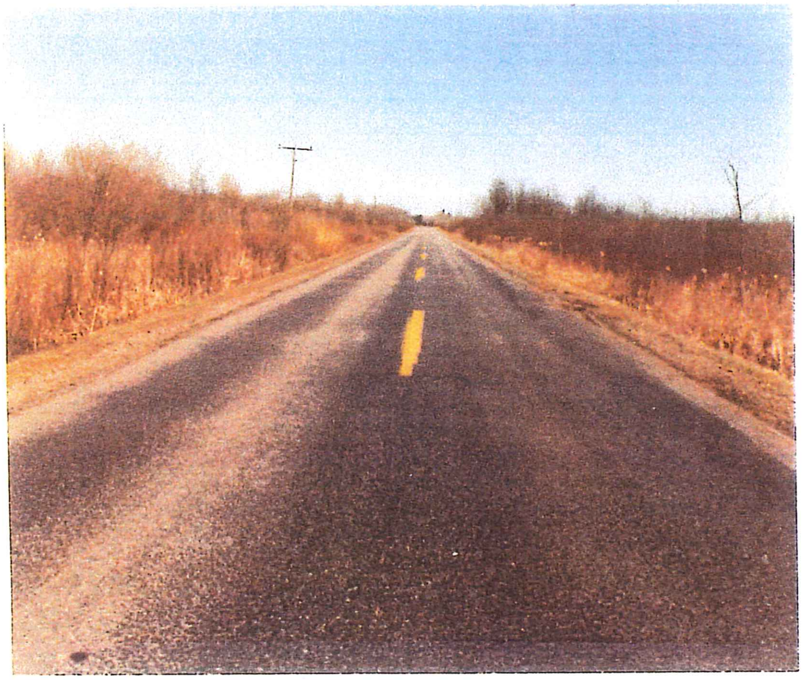


Figure A46.

Severity = 1 Extent = 2
Minor waves can be seen in the distance.

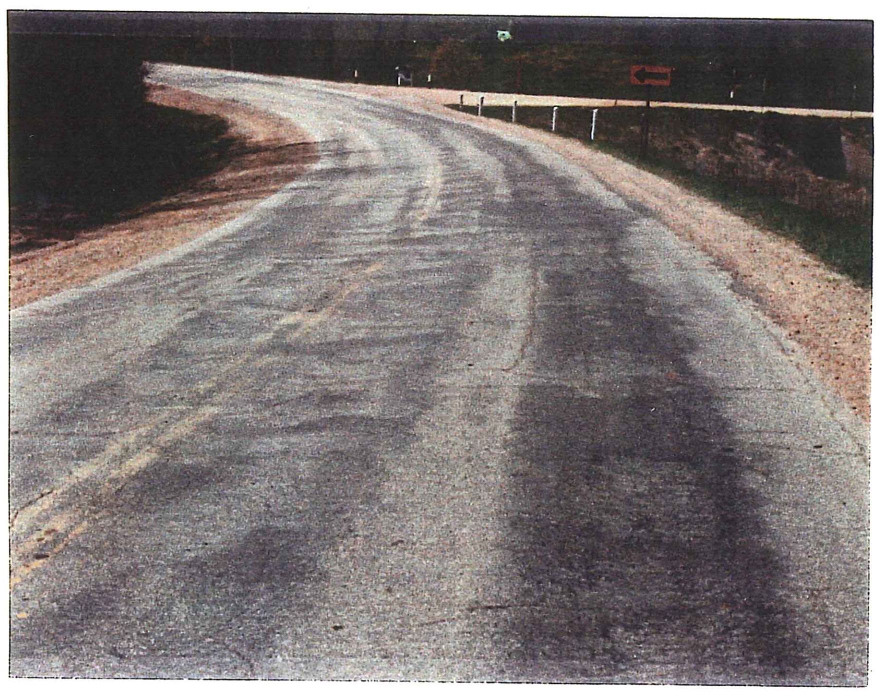


Figure A47.

Severity = 1 Extent= 3

Corrugation as a result of shoving. The extent rating is based on the pavement prior to the curve.

LONGITUDINAL DISTORTION

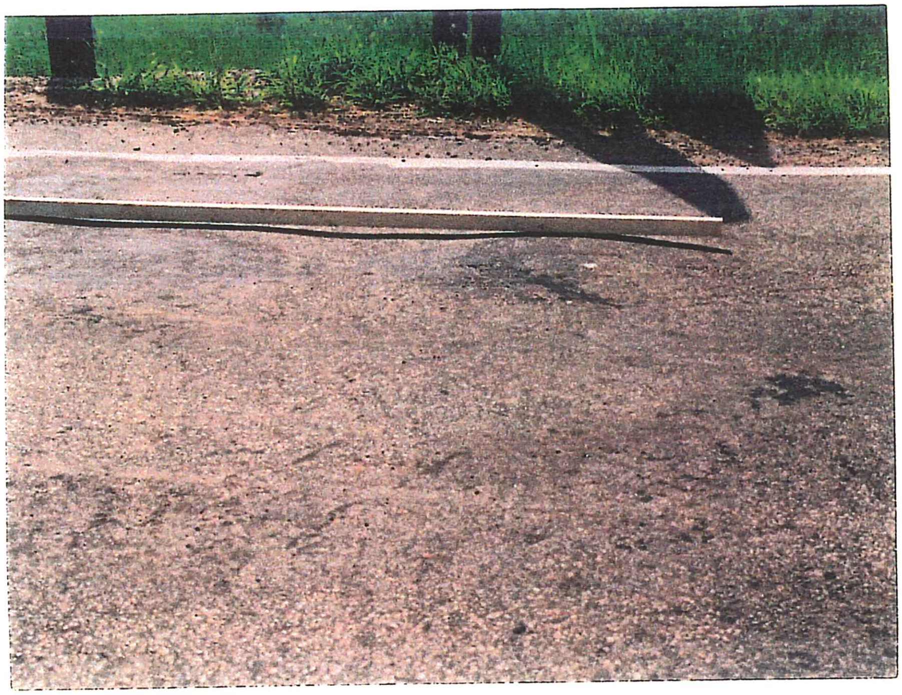


Figure A48.

Severity = 1 Extent = 1

The pavement beneath the straight edge is clearly corrugated.

Figure A49.

Severity = 1 Extent= 3

Shoving due to unstable mix.

TRANSVERSE DISTORTION

Definition: Distress indicator which incorporates all pavement distresses resulting in, or the result of, a change in the intended **transverse profile** (cross-section) of the pavement. Typical distresses[12] in this category are:

Edge Tipping: A condition caused by the outer edge of the pavement tipping upward (or downward). This condition is often associated with the widening strip placed alongside a narrow pavement prior to an overlay.

Edge Roll-down: The downward movement/shoving of the mix near the edge due to the effects of traffic.

Severity

0 = none or insignificant

1 = yes, it exists to a significant degree

Extent

The extent of distortion is rated according to the percentage of the roadway pavement width that is affected.

0 = none

1 = 1 - 24%

2 = 25 - 49%

3 = greater than 50%

[12] ***Distortion that may have been "built into" a pavement, e.g., a parabolic cross-section, is nevertheless distortion and should be rated if significant. Parabolic cross-sections may exist on some urban roadways.***

[illegible]

[illegible] which [illegible] used [illegible] Typical [illegible]

Frost Heave [illegible] A [illegible] the [illegible] edge of the pavement appears [illegible] This condition is often associated with [illegible] widening strip placed along [illegible] overlay.

[illegible] [illegible] The downward movement/slough [illegible] near the edge due to [illegible] traffic.

Severity

0 = none or insignificant

1 = yes, it exists to a significant degree

Extent

The extent of distortion is rated according to the percentage of the roadway pavement width that is affected.

0 = none

1 = 1 - 24%

2 = 25 - 49%

3 = greater than 50%

[illegible] but may have been [illegible] pavement, [illegible] cross-section [illegible] and should be noted if significant. Parabolic cross-sections [illegible] machinery.

Figure A50.

Severity = 1 Extent = 1

The right end of the range pole indicates significant edge settlement

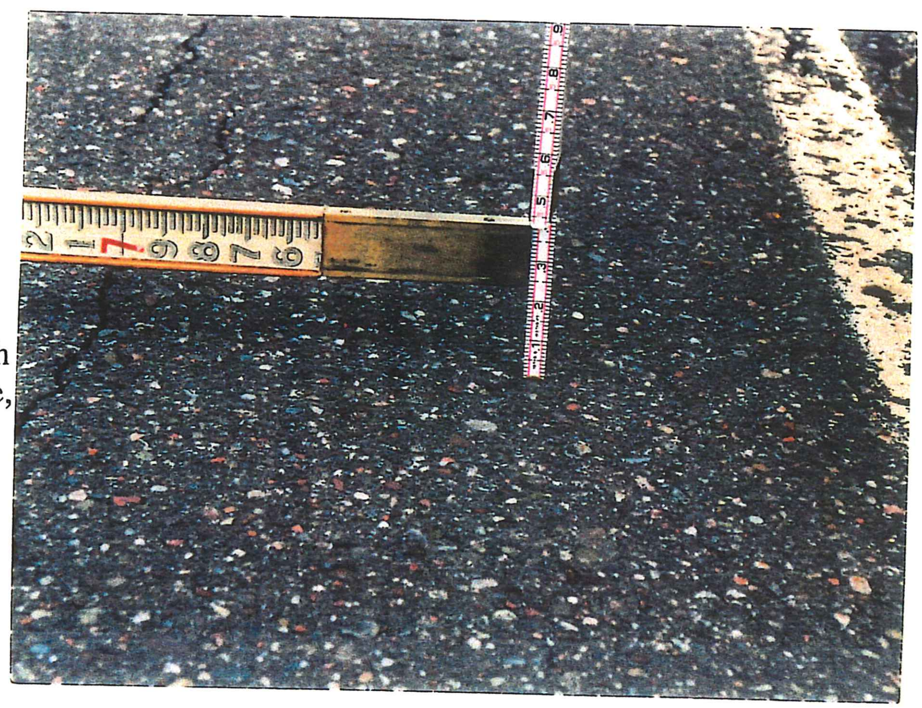


Figure A51.

Severity = 1 Extent = 1

A close-up of the right wheel-path indicating a roll-down of the edge, associated with a widened pavement.

TRANSVERSE DISTORTION

Figure A52.

Severity = 1 Extent = 1

The right wheel-path shows a case of edge tip-up commonly associated with a widened pavement.

SEGREGATION

Definition: The non-uniform distribution of aggregate with differing sizes. Segregation involves a concentration of coarse materials in one area and fines in another. It is generally the areas containing coarse[13] materials that are readily visible, especially under moist conditions or at low angles of light.

Causes: Segregation may be caused by truck loading/unloading operations, paver operation, stockpiling and handling, asphalt mixing plant operations, and operational characteristics of the equipment, and the mix design itself.

The illustrations provided below show various patterns of segregation. These illustrations, when used with the accompanying photographs, should help the rater evaluate the distress correctly. Segregation may not be noticeable to the rater in certain weather and lighting conditions. The best way to identify segregation is to observe the surface in a wet condition. Segregated areas, which are not visible from one angle may become visible from a different position. In this case, viewing the pavement surface at a low light angle will yield the best results.

Severity

No severity level has been established for segregation. This distress indicator is currently used to provide information to the Materials and Design Engineers.

Extent

0 = No segregation

1 = 1 or 2 segregated areas per segment

2 = 3 or more segregated areas per segment

---

[13] ***Asphaltic concrete surfaces which exhibit segregation contain areas which are open textured. The open texture and low density allow moisture to permeate the mixture, resulting in durability-related premature distress such as raveling, cracking, and joint separation.***

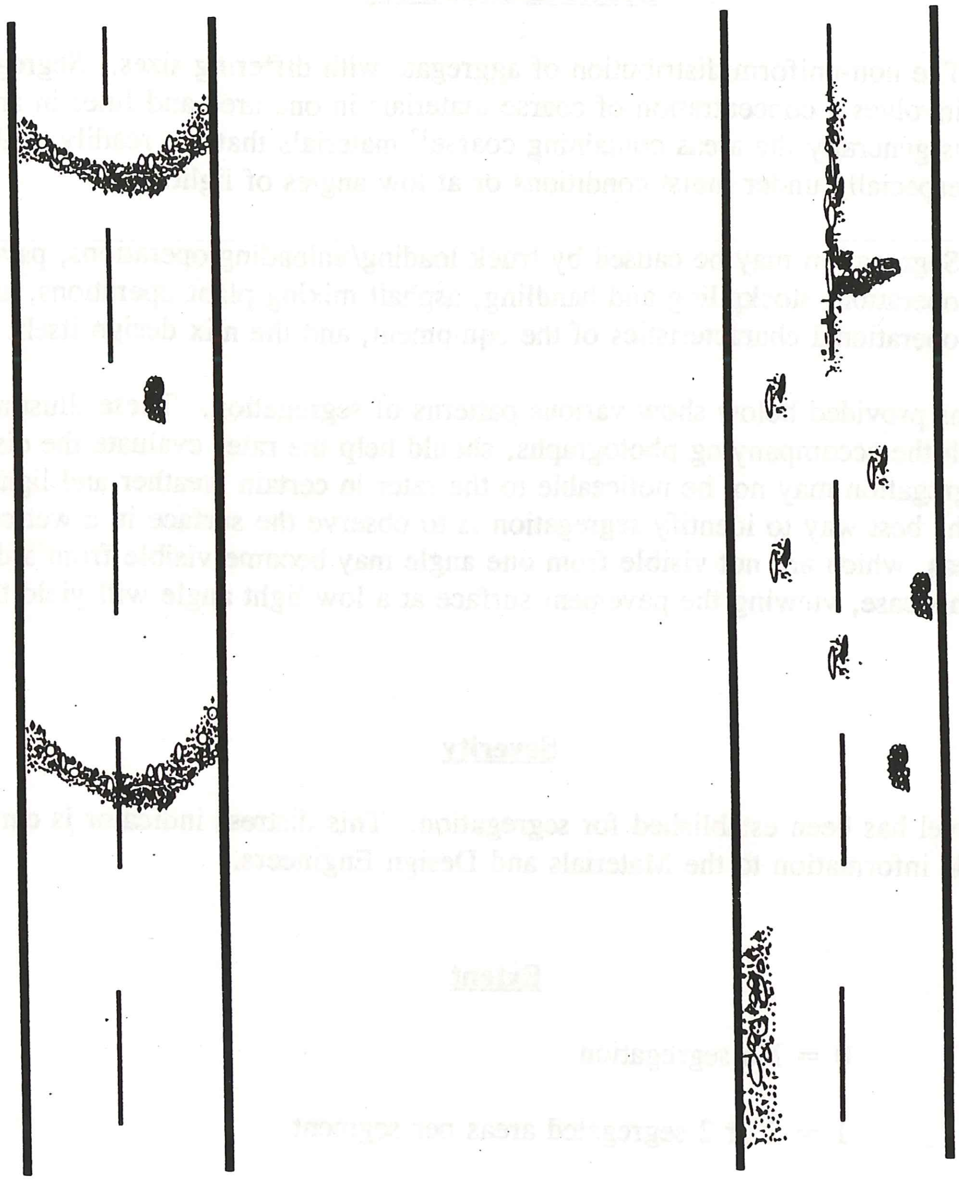


Figure A53. Segregation.

Typical Segregation patterns

This type of segregation pattern extends across the mat and normally occurs every 150 feet or between truck loads.

Other patterns

Other segregation patterns occur randomly, systematically on either side, continuously on one side, continuously at the longitudinal joint or continuously on both sides.

SEGREGATION

Figure A54.

Extent = 1

Segregation seen along the longitudinal joint of a newly constructed pavement surface.

SEAL COATING

Definition: Emulsified asphalt sprayed on the pavement with aggregate chips applied (Fog seal, a special treatment[14], may be used for severely oxidized pavements).

Seal Coat is not a distress indicator. Seal Coat is included in this manual to provide additional information on the condition of the pavement surface at the time distress survey is conducted. Seal coats obscure distress and therefore affect the PDI. **Indicate in the Seal Coat column (1=yes) that a seal coat is recent if no distress is apparent. Unless the Seal Coat masks the distress completely, do not rate it as existing. A seal coated surface that shows distress should always be rated as zero, i.e., no seal coat.** No we still consider it to be seal coated.

Extent

0 = None

1 = Seal coating is recent enough to mask pavement distress

---

[14] Special pavement surface treatments are currently used to rehabilitate a distressed section of roadway in the state. These treatment alter the original surface, e.g., wedging, milling, overlays, base patching etc.

SEAL COATING

Figure A55.

Extent = 0

The pavement in the photo at far left has never been seal coated. The photo at near left show a pavement that was sealed in the past. The entry in the Seal Coating column in the Inventory Data Sheet should be a "0".

Figure A56.

Extent = 1

Seal coating is recent enough to mask distress.

CRACK FILLING

Definition: Crack Filling is not a distress indicator. However, it is included in this section to provide additional information. This indicator is used for reference purposes only, i.e., to explain changes in the computed PDI values over the life of a pavement surface. All types of crack filling, such as routing, should be rated under this distress category.

Rating

0 = filled adequately

1 = filled in past but in need of additional filling

2 = never filled

Figure A57.

Rating = 1

Filled in the past but needs additional filling.

CRACK FILLING

Figure A58.

Rating = 2

The cracks have never been filled.

PORTLAND CEMENT CONCRETE

DISTRESS INDICATORS

The following section present a detailed description of each distress indicator and the method for establishing severity and extent of the distress.

RIGID PAVEMENT SURFACE DISTRESS

General

The most significant and severe distresses in jointed concrete pavements generally occurs along joints. Joint deterioration leads quickly to a loss in ride quality and structural failure of the pavement. Other distress types occur within a slab away from joints and eventually lead to pavement failure. This Section presents descriptions of the most common pavement surface distress indicators in PCC as identified by WisDOTs' C.O Materials. Each distress indicator is described along with current thinking regarding the general mechanism or cause of the underlying stress. Various levels of distress severity and extent are defined, and measurement criteria are provided. Guidelines for distinguishing between severity levels and between extent levels of individual distress indicators are presented and explained.

Pavement Types

The distress indicators covered in this section are those associated with Pavement type 4, 5, 6, and 8. Pavement types are defined below.

Pavement Type	Description
4	Jointed Reinforced Concrete Pavements(JRCP)
5	Jointed Plain Concrete Pavements without dowels(JPCP)
6	Continuously Reinforced Concrete Pavement (CRCP)
8	Jointed Plain Concrete Pavements with dowels (JPCP /d).

Distress Categories for PCC

Since severity and extent of the distresses within the survey segment determine the PDI rating for that segment, guidelines for rating severity and extent are given for each distress indicator. Illustrations and photographs of various distress indicators are provided to aid in distress identification and evaluation.

The photographs under each distress indicator are arranged so that the least severe distress with the lowest extent level appears first. An attempt was made to include as many typical photographs as possible. However, it is not possible to include all occurrences of distress indicators in this manual. Where questions arise, the field crew will decide the category in which to include the distress in question.

PCC distress currently surveyed by Pavement Management and district staff are listed below.

1.	Slab Breakup		**Additional Distress for CRC Pavements**
2.	Joint Crack Filling	8.	Wide Cracks
3.	Distressed Joint/Cracks	9.	Punch Outs
4.	Patching	10.	Diagonal Cracking
5.	Surface Distress	11.	Pavement Deterioration
6.	Longitudinal Joint Distress	12.	Delamination
7.	Transverse Faulting		

Table R1. Observable distress in rigid concrete pavements.

The distress indicators shown above include five distress indicators that are rated when surveying CRC Pavements. The first seven distress indicators as well as Joint/Crack filling should be evaluated for all non-CRC Pavements.

Figure R1 on page 62 denotes some of the distress indicators for PCC Pavements. Note that corner breaks should be rated under distressed joint/cracks. Distress indicators that do not readily fall in any of the above categories should be evaluated under an appropriate category as well as noted as remarks on the data entry forms.

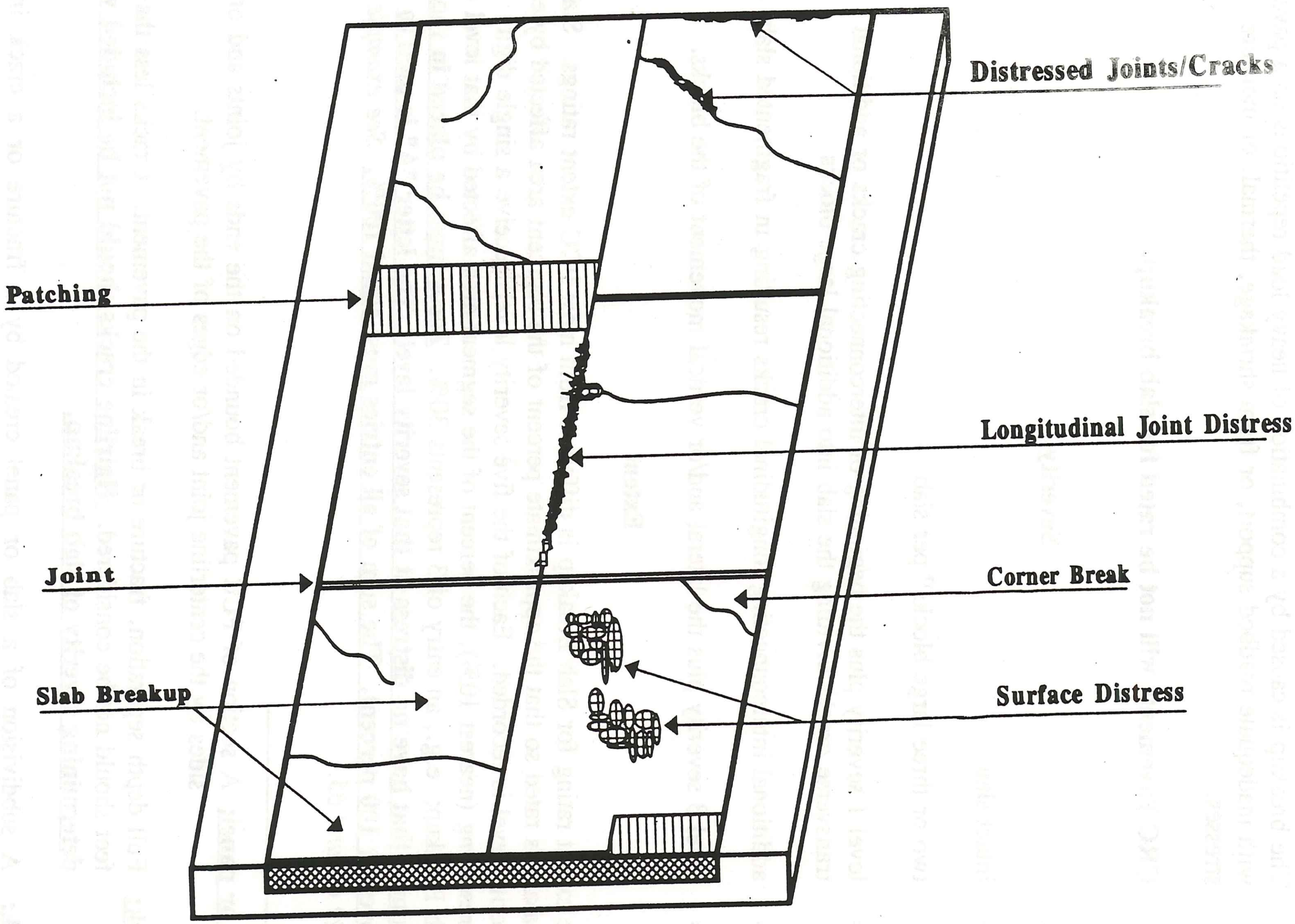


Figure R1. PCC Pavement Surface Distresses.

Illustration of five Portland Cement Concrete surface distress types. A corner break is also shown. Faulting and Rutting are illustrated under their respective sections.

SLAB BREAKUP

Description: Slab[15] Breakup is the fracturing of a slab due to crack[16] development.

Cause: The breakup is caused by a combination of heavy load repetitions on a pavement with inadequate roadbed support, or from shrinkage, thermal, or moisture stresses.

NOTE: **CRC Pavements will not be rated for slab breakup.**

Severity

0 = intact slab

1 = two or three large blocks[17] per slab

2 = level 1 severity plus the beginning of interconnecting cracks or additional transverse cracks dividing the slab into additional large blocks

3 = additional interconnecting longitudinal cracks resulting in fragmented slabs

4 = level 3 severity plus the lateral and/or vertical movement of the blocks.

Extent

The extent rating for Slab Breakup is different from most PCC extent ratings. Slab Breakup is rated so that the approximate percent of the segment area affected by each severity level is recorded. Each of the five severity levels receive a single digit representing (nearest 10%), the percent of the segment area affected by that level of Slab Breakup; e.g., an entry of 3 represents 30%. **Zeros must be placed in those columns that have no distress at that severity level. The letter "A" is used to represent 100 percent. The sum of all entries must equal 100%.** *See example on page 64 and 65.*

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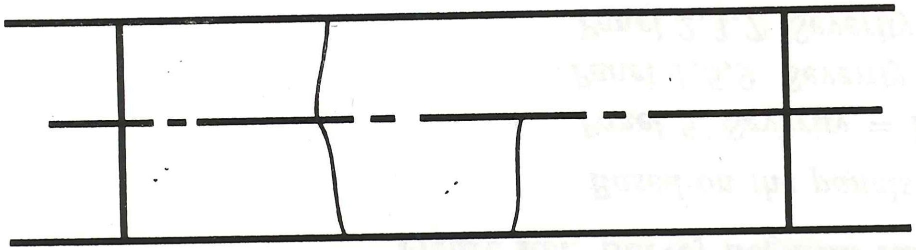
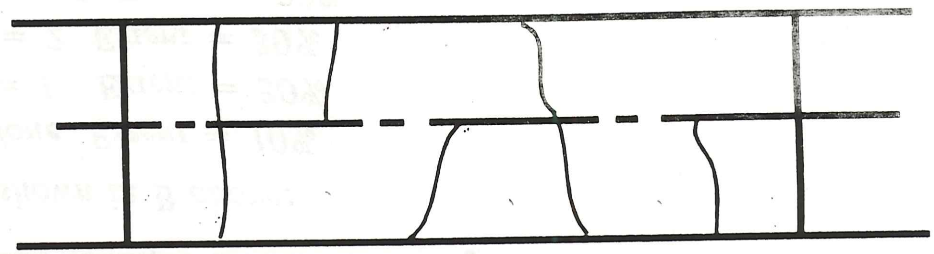
[15]**Slab or panel:** A section of PCC pavement bounded on the ends by joints and on the sides by the centerline joint and/or edges of the pavement.

[16]**Crack:** Full depth separation, fracture or break in the pavement. Cracks less than six feet should not be considered. **Hairline cracks should not be included when determining severity of slab breakup.**

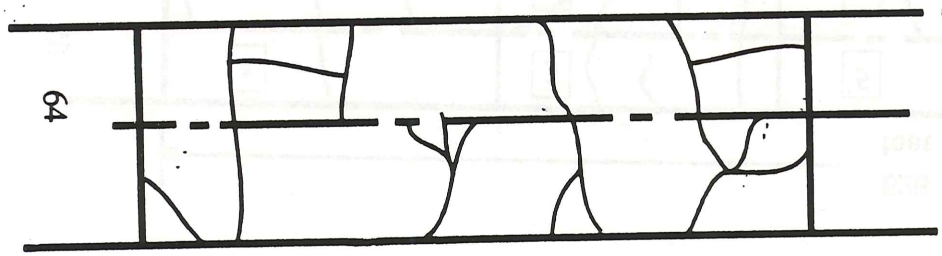
[17]**Block:** A subdivision of a slab or panel created by a fracture or a crack in the pavement(PCC).



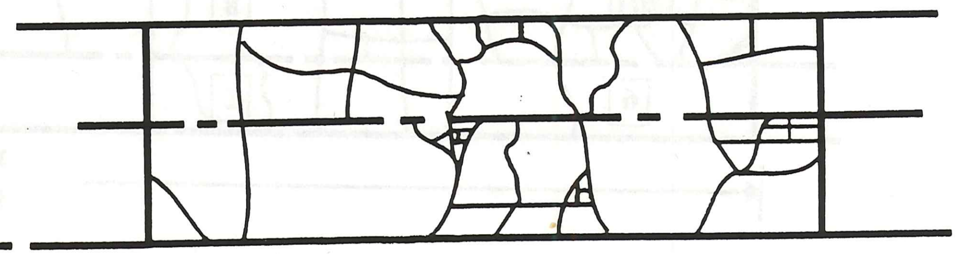
Both panels Severity level = 1
Extent = 10%



Both panels Severity Level = 2 Extent = 10%.
Additional transverse cracks.



Both panels Severity Level = 3
Additional interconnecting
longitudinal cracks.



Both Panels Severity Level = 4
Lateral and/or vertical movement of
the blocks

Figure R2. Slab Breakup.

The diagrams above illustrate four severity levels of slab breakup. Each diagram shows two lanes. Each lane is made up of one slab, 100 feet in length. Illustrations on page 65 show cases where the two slabs may have different severities.

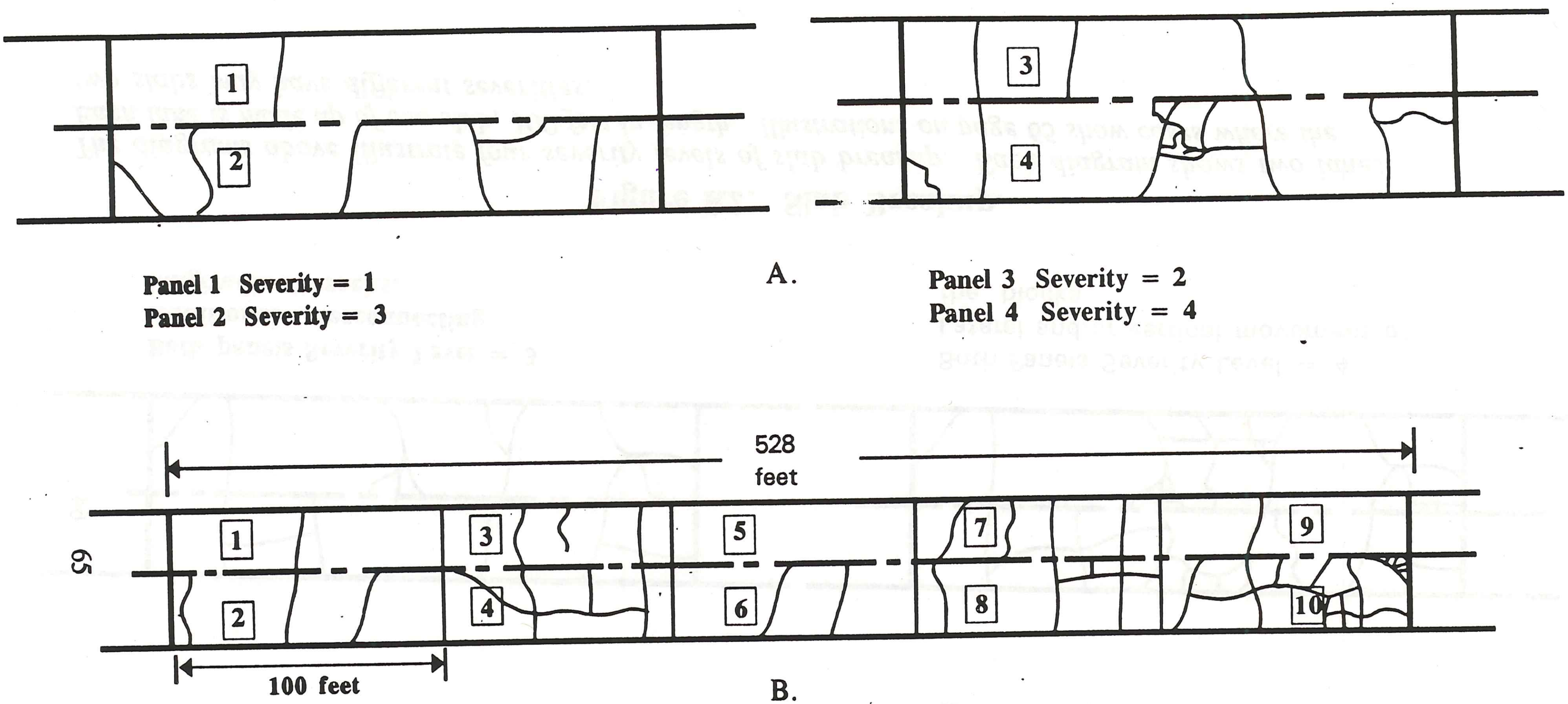


Figure R3. Survey Segment Rating example on Slab Breakup.

Based on the panels shown in B above:

Panel 5 Severity = None Extent = 10%
Panel 1,6,9 Severity = 1 Extent = 30%
Panel 2,3,7 Severity = 2 Extent = 30%
Panel 4 and 8 Severity = 3 Extent = 20%
Panel 10 Severity = 4 Extent = 10%
Total of Extent = 100%

SLAB BREAKUP

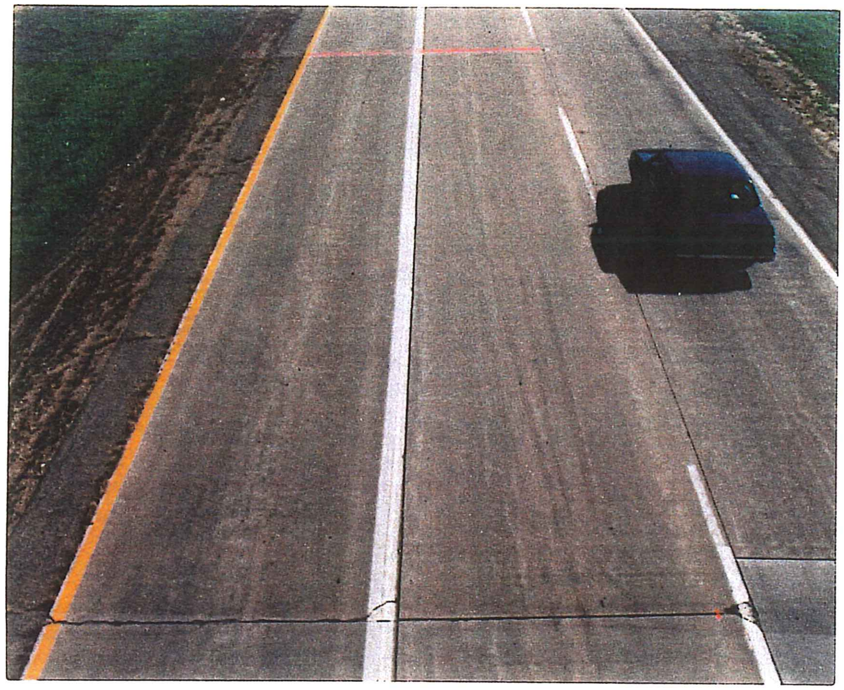


Figure R4.

Severity = 0 @ 20%

The slabs are intact except the two small corner breaks. The corner break are rated as part of the distressed joints/cracks.

Figure R5.

Severity = 1 @ 100%

Transverse cracks have divided each slab into 2 or 3 blocks.

SLAB BREAKUP

Figure R6.

Severity = 3

Additional interconnecting longitudinal cracks resulting in fragmented slabs.

Figure R7.

Severity = 3 @ 50% (left lane)
Severity = 1 @ 50% (right lane)

Longitudinal cracks interconnecting with transverse cracks have divided the slabs in the left lane into additional large blocks. The slabs in the right lane are divided into two to three large blocks.

SLAB BREAKUP

Figure R8.

Severity = 3

Longitudinal cracks run along the wheel path and interconnect with transverse cracks to divide the slab into smaller blocks.

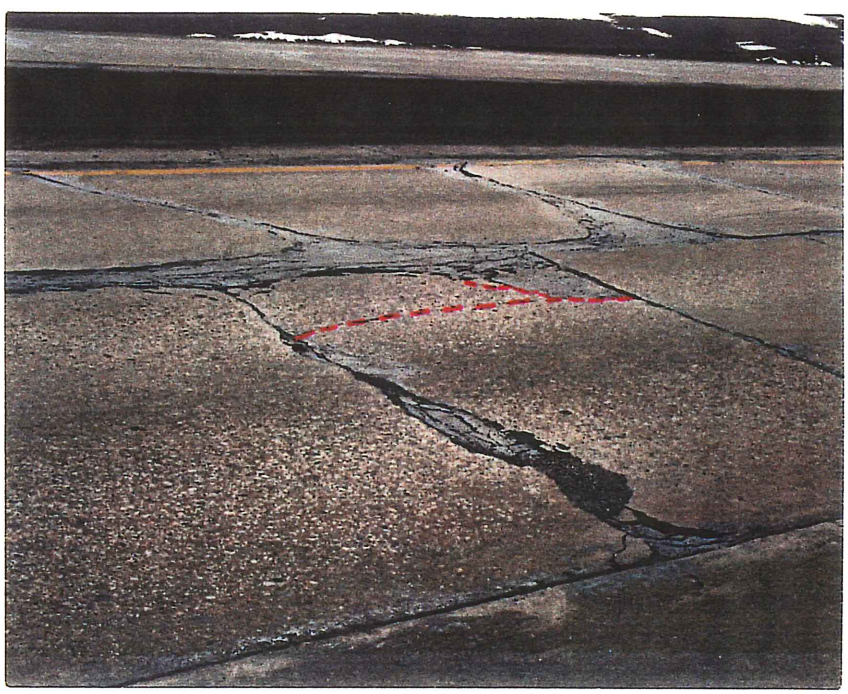


Figure R9.

Severity = 4

More transverse cracks have divided each slab into smaller blocks. Longitudinal cracks have also developed resulting in fragmented slabs. There is vertical movement as shown by the red dashed line.

JOINT/CRACK FILLING

Description: Joint/Crack Filling is not a distress indicator but, is included in this section to provide additional information. This indicator is used for reference purposes only, i.e., to explain changes in the computed PDI values over the life of a pavement surface.

Rating

0 = filled adequately

1 = filled but in need of additional filling

2 = never been filled

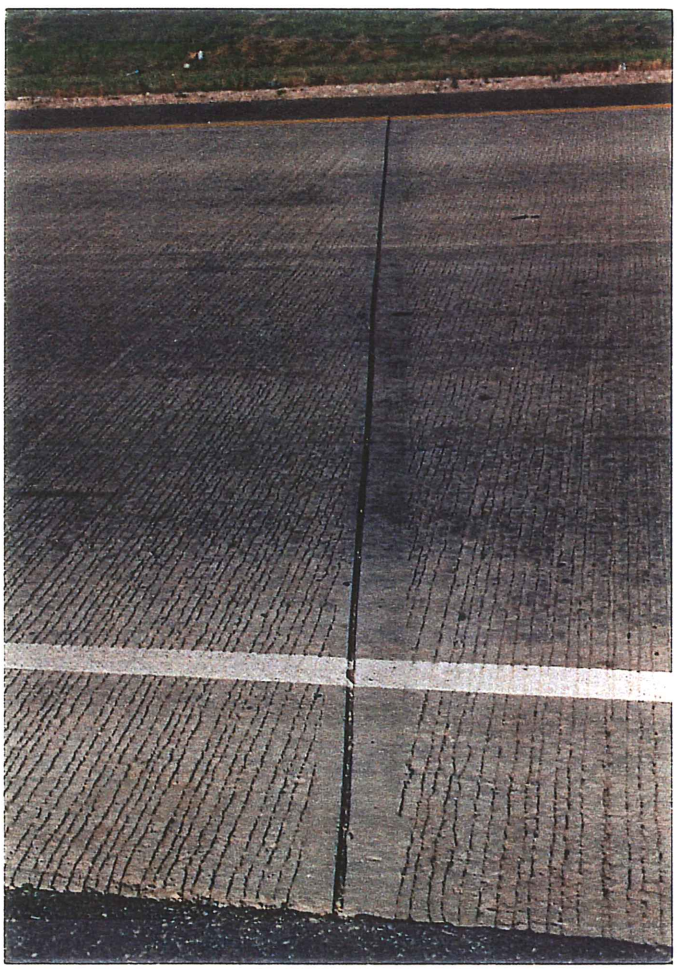


Figure R10.

Rating = 2

Never been filled. The contraction joint sealer is not considered as joint filling since it is part of the initial construction specification of the pavement.

JOINT/CRACK FILLING

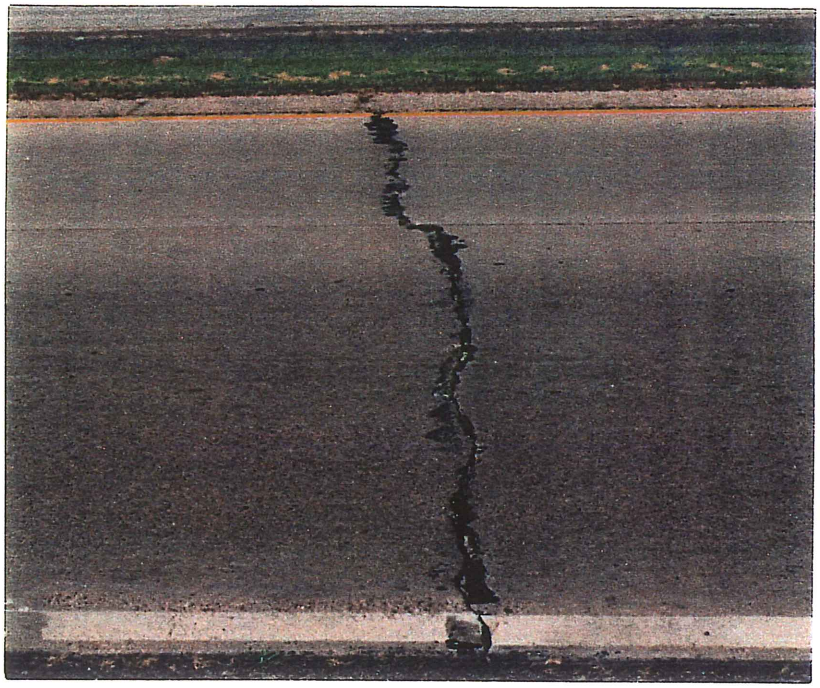


Figure R11.

Severity = 1

Filled but needs more filling. Note that some part of the cracks are starting to spall.

Figure R12.

Rating = 0

Filled adequately. The filling is extruded from the crack by the action of traffic. When rating cracks that have been filled, care should be taken to avoid exaggerating the width of the joint/or crack.

DISTRESSED JOINTS/CRACKS

Description: This is a distress item concerned with the deterioration of the concrete in the immediate vicinity of a Joint or crack. Distressed Joints/Cracks[18] includes any distress within two feet on either side of a joint or crack.

Causes: Distresses at joints or cracks may be caused by a number of factors:

1. **D-cracking** is a series of closely spaced crescent-shaped hairline cracks in the concrete surface usually paralleling a joint or major crack and usually curving across slab corners.
2. **Spalling** is a breakdown of slab edges at joints or cracks or directly over reinforcing steel, usually resulting in the removal of sound concrete.
3. **Dowel assembly** problems generally result from improper placement of dowel basket (or individual dowel bars in the case where dowel insertion is performed automatically by the paver) causing the joint to lock up.
4. **Longitudinal Cracks** are caused by lateral contraction, lateral movement and settlement of the roadbed.

Severity

0 = none (no distress present)

1 = slight (early stages of distress and/or a slight loss of material within the joint/crack). **Distress in wheel path is 2-4 inches wide.**

2 = moderate (any of the following conditions may affect the rating;deterioration of the distressed area; moderate loss of material within the joint/crack and/or slight effect on ride or safety). **Distress in Wheel path is 6-10 inches wide.**

3 = severe (significant breakup; loss of the material within the joint/crack resulting in a major effect on ride or safety; at this severity level patching of the distressed joints/cracks is more frequent). **Distress in the wheel path is greater than 10 inches.**

Extent

Distressed Joints/Cracks

0 = none

1 = 1 - 2 per station

2 = 3 - 4 per station

3 = more than 4 per station

Random Longitudinal Cracking

0 = none

1 = 1-48 feet per station

2 = 49-96 feet per station

3 = 97 or more feet per station

[18] All distressed Joints and Cracks with the **exception of Longitudinal Lane Joints** are included under this category. All random longitudinal cracks are included under Distressed Joints and Cracks. A discussion of Longitudinal Joint Distress is given on page 92. Note that the extent cannot be rated from the attached photos.

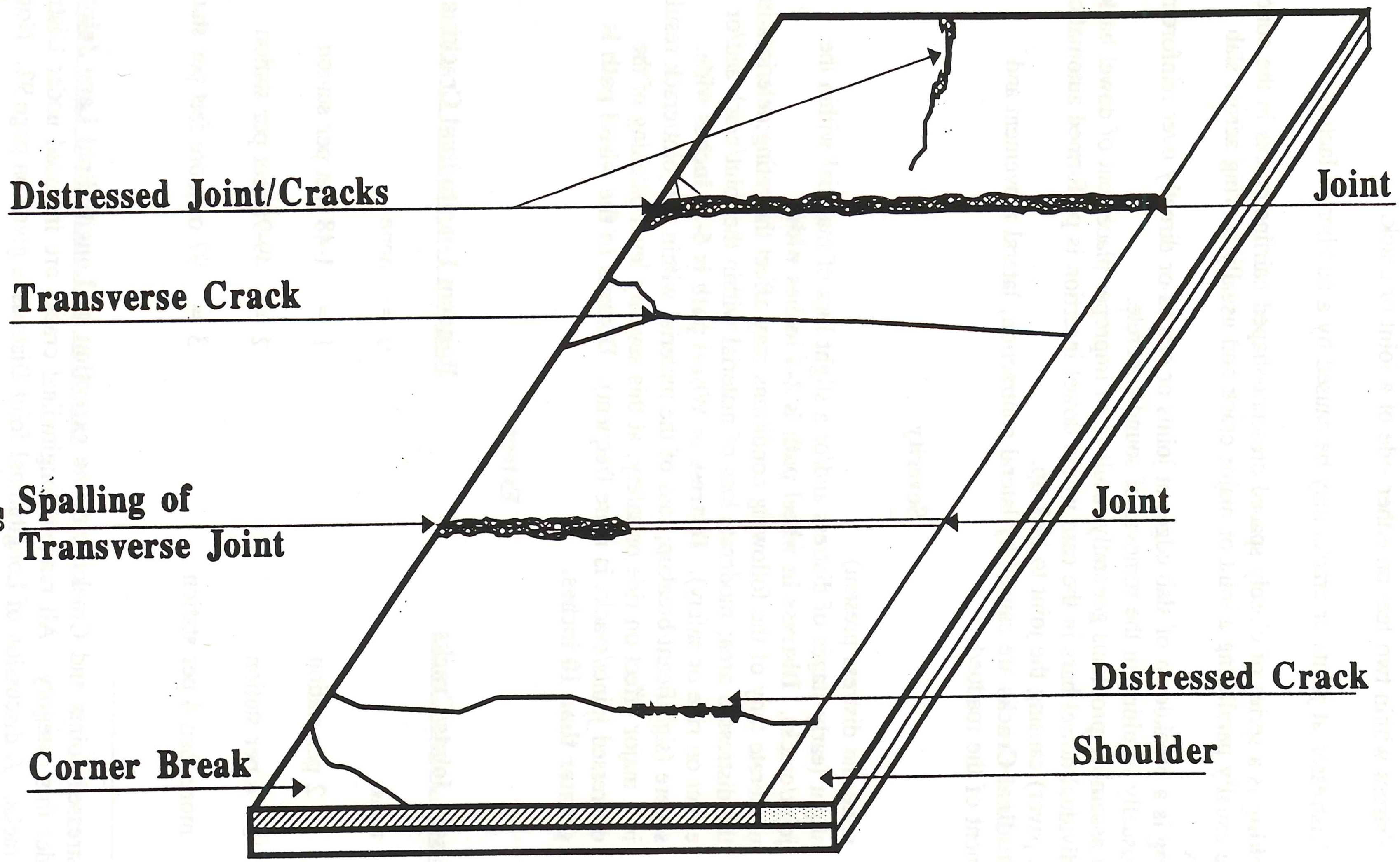


Figure R13. Distressed Joints/Cracks

Corner breaks should be rated under this category. Spalled joints and cracks should also be evaluated under distressed Joint/Cracks category.

Figure R14.

Severity = 1

Minor spalls near the inner wheel path.

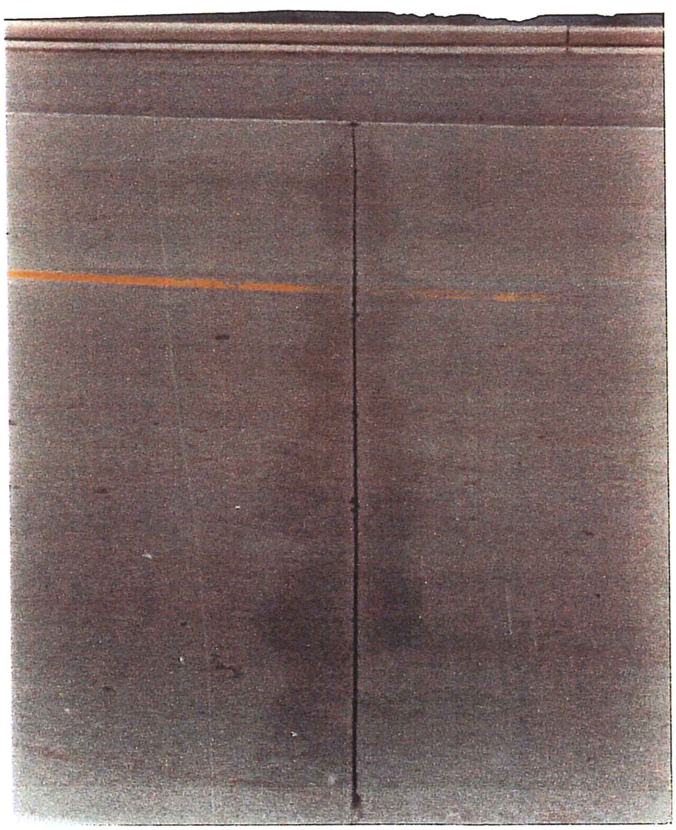


Figure R15.

Severity = 1

This joint is also rated as severity level 1. The dark stains along the crack are indications of early distress. This staining is typical of a joint with the beginning stages of D-Cracking. There are fine crescent shaped cracks within this stained area.

DISTRESSED JOINTS/CRACKS

Figure R16.

Severity = 1

Note the width of the crack. The crack shows some spalling of the edges.

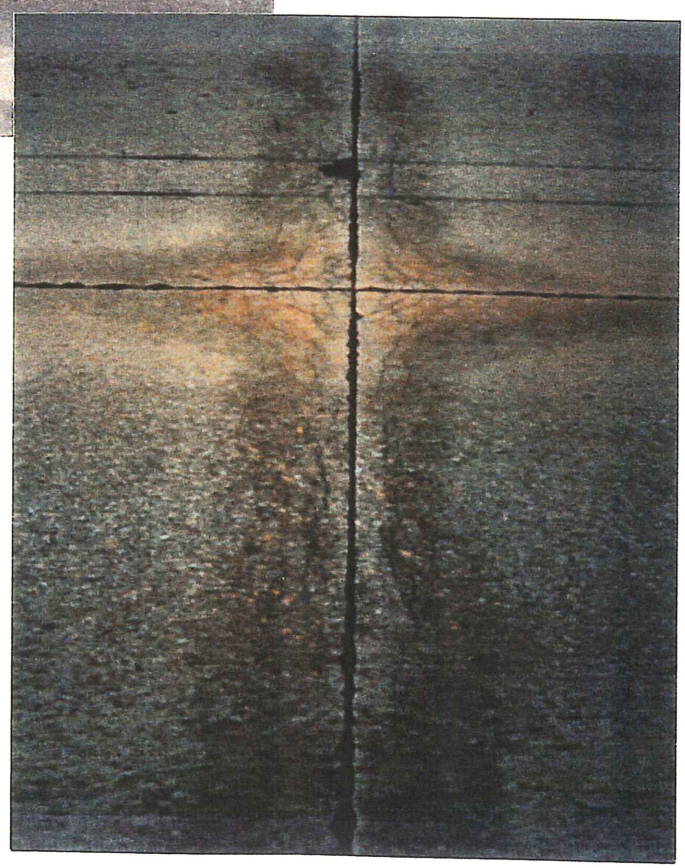


Figure R17.

Severity = 2

The dark staining on each side of the joint show a typical appearance of D-cracking. There are fine cracks along the edges of the joint and at the center (diamond outline). The distress is between 6-10 inches in width.

DISTRESSED JOINTS/CRACKS

Figure R18.

Severity = 2

Breaking at the interior and exterior corners of the joint is evident.

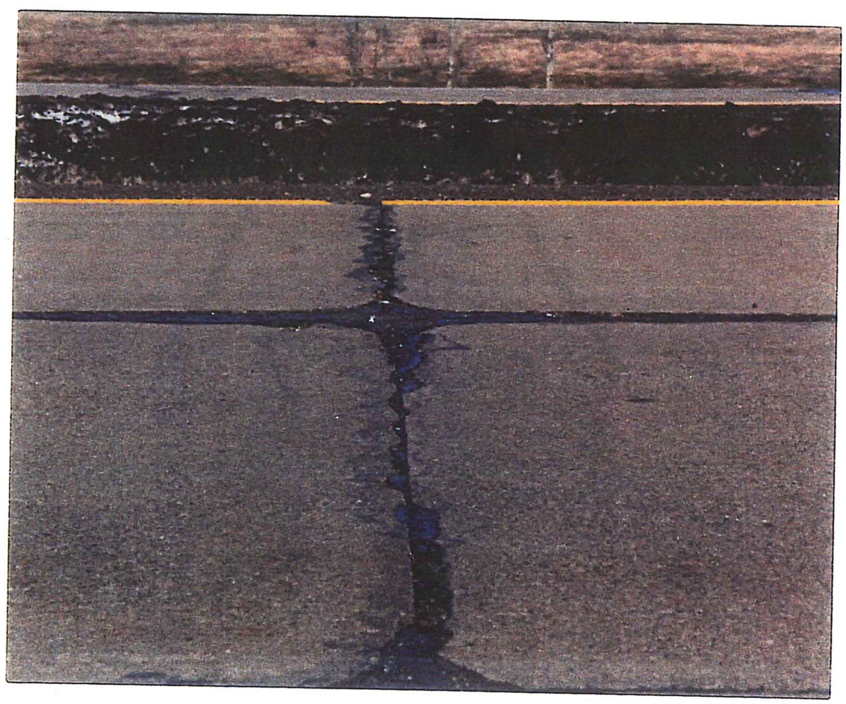


Figure R19.

Severity = 2

The Joint has spalled to a point where pavement material at the joint is lost. Joint filling does not stop the progressive deterioration at the joint.

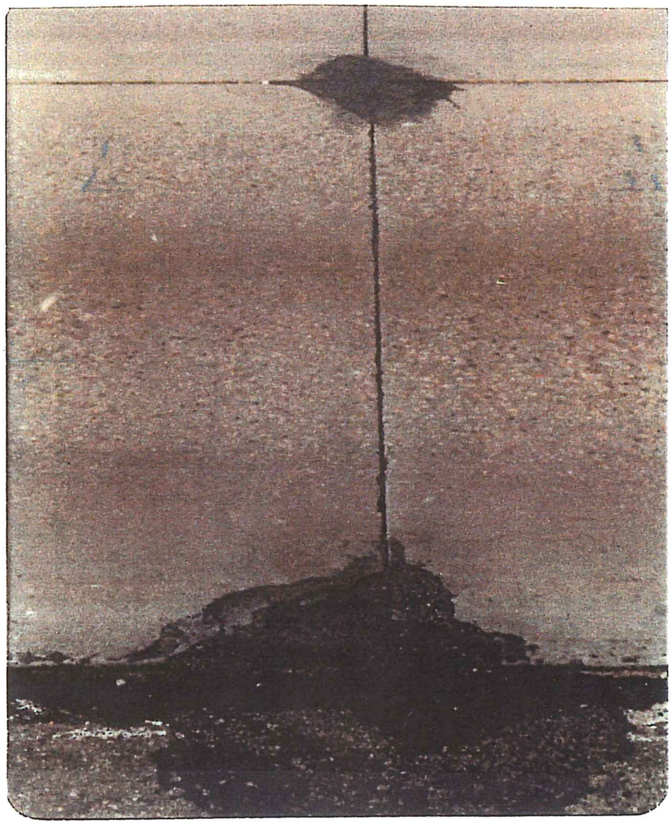


Figure R20.

Severity = 2

Moderate loss of material at the ends of the joint is evident. Note the corners of the slab are breaking away.

Figure R21.

Severity = 2

The distress near the centerline lane joint has progressed to the point that a moderate loss of material has occurred. The width of the distress at the centerline lane joint is greater than 4-6". The distress near the centerline appears to run longitudinally, the appropriate distress category would be longitudinal joint distress.

DISTRESSED JOINTS/CRACKS

Figure R22.

Severity = 2

Here the distress is widest at the edge of the lane. Crack spalling and breaking at the centerline are wide but should be considered under longitudinal Joint distress. In this case, distresses within two feet of the longitudinal joint are rated as longitudinal joint distress.

Figure R23.

Severity = 3

Borderline severity levels 2 and 3. If the Joint/Crack distress is widest in the wheel path, the higher severity level is used.

DISTRESSED JOINTS/CRACKS

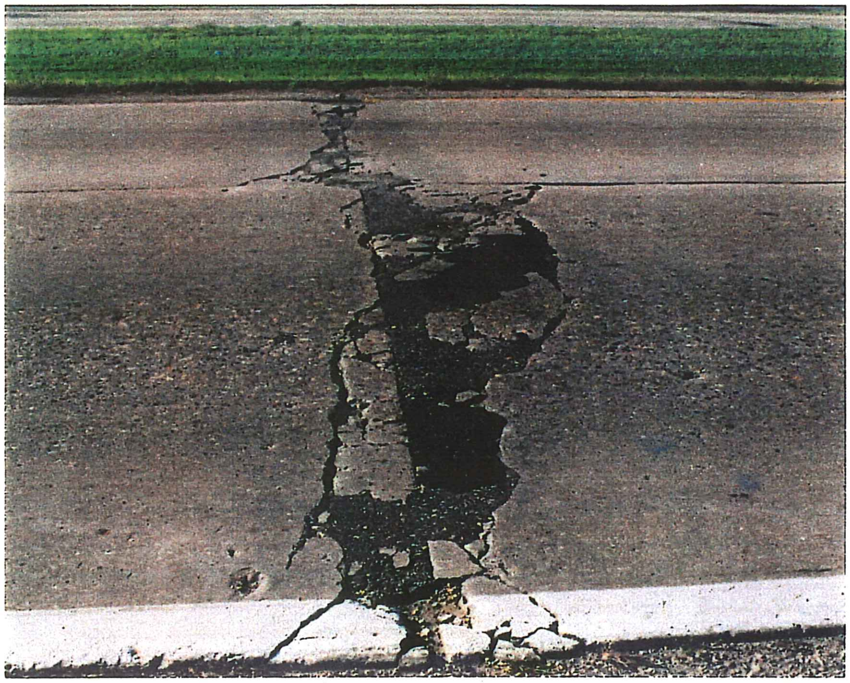


Figure R26.

Severity = 3

The joint has progressed to the point where ride quality is very poor. There is failure of joint transfer efficiency.

Figure R27.

Severity = 3

The distress at the joint affects ride, especially in the wheel path where it is wider. There is dislodgement at the joint resulting in a safety hazard from flying debris. Fine cracks can be seen at the edge of the pavement.

DISTRESSED JOINTS/CRACKS

Figure R28.

Severity = 3

The photo on the left shows a blowup. This distress is not a poorly performing patch but simply a severely distressed joint.

Figure R29.

Severity = 3

The distress is covered with an asphaltic mix to prevent dislodgement of pavement surface material. This is another case of pavement blowup and should not be rated as a patch.

PATCHING

Description: Patches are **permanent**[19] repairs to damaged pavement. Patches may be full or partial depth (also full or partial lane) consisting of either AC or PCC.

Severity

0 = patches not present

1 = **good** condition, performing satisfactorily

2 = **fair** condition, a little deterioration, some spalling at the joints, may have some faulting across the slab/patch joint and ride quality is affected to some extent

3 = **poor** condition, patch has deteriorated by spalling and cracking within the patch, patch needs to be extended, replaced, or repaired; ride quality is affected.

Extent

The extent of patching is based on the number of patches per segment. The number of patches within each segment is counted and recorded according to severity levels. A tally of all patches within each severity level is kept. The 25 Percent Rule is applied to the tallies starting with the left most (most severe) column. The highest severity level which constitute 25% or more of the patching distress is recorded. *See Example on page 82 and Appendix C, page 129.*

0 = none

1 = 1 - 3 per segment

2 = 4 - 6 per segment

3 = 7 - 9 per segment

4 = 10 or more per segment

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[19] **Permanent Repairs are cases where a level of effort was paid to the repair such that sawing and removal of existing surface was performed to assure good performance of the repair.**

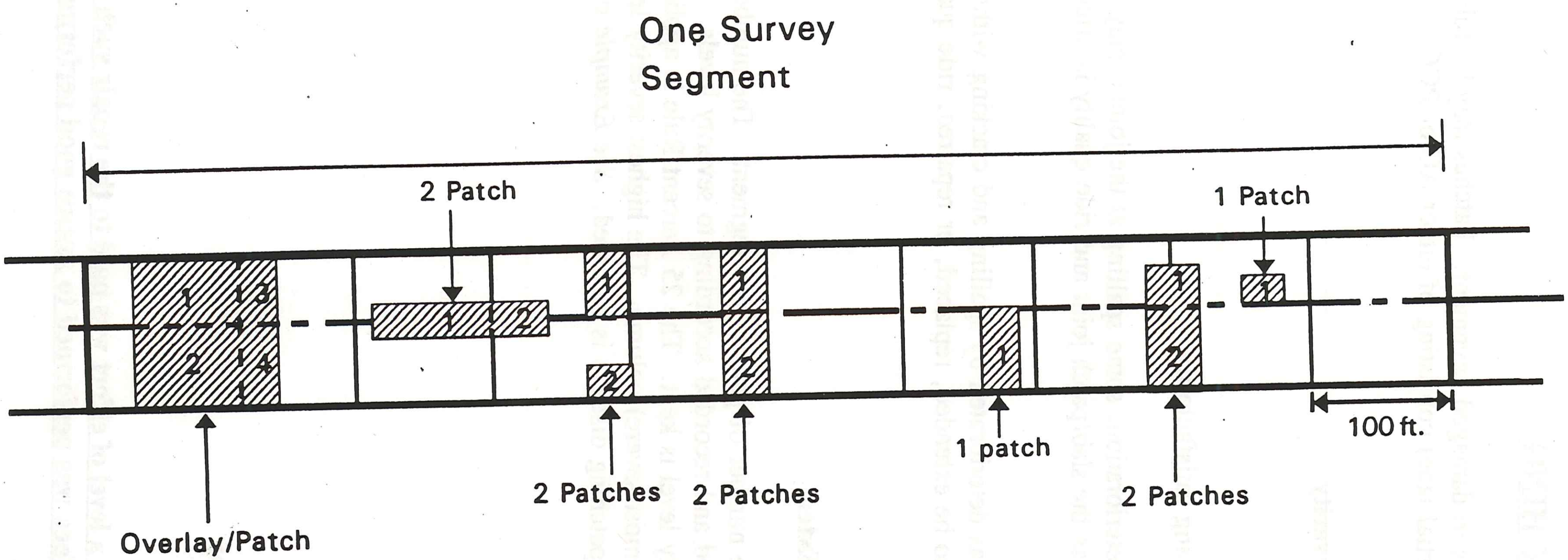


Figure R30. Patching.

This illustration shows a segment of a two-lane PCC pavement which has been patched with various sizes of patches. This segment has 14 patches. The severity is computed from the Work-sheet and based on the 25% Rule. Extent = 4.

Overlay/Patch: This area should be considered as two patches. If the overlay/patch extends over two joints, as shown, the number of patches is Four.

PATCHING

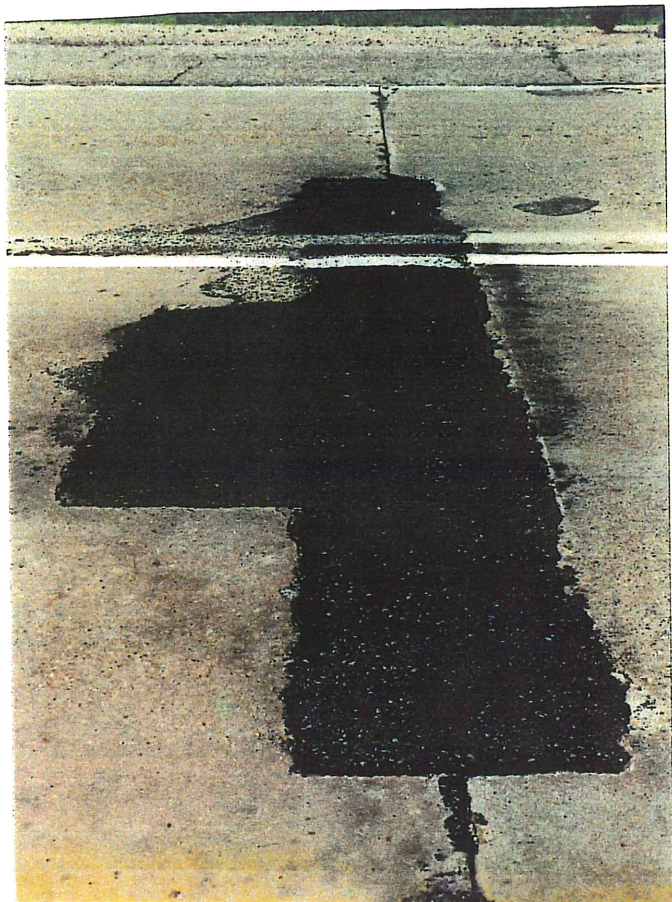


Figure R31.

Severity = 1

These Asphaltic Concrete patches are permanent repairs (due to the rectangular shape of the area) to a PCC Pavement and are in good condition.

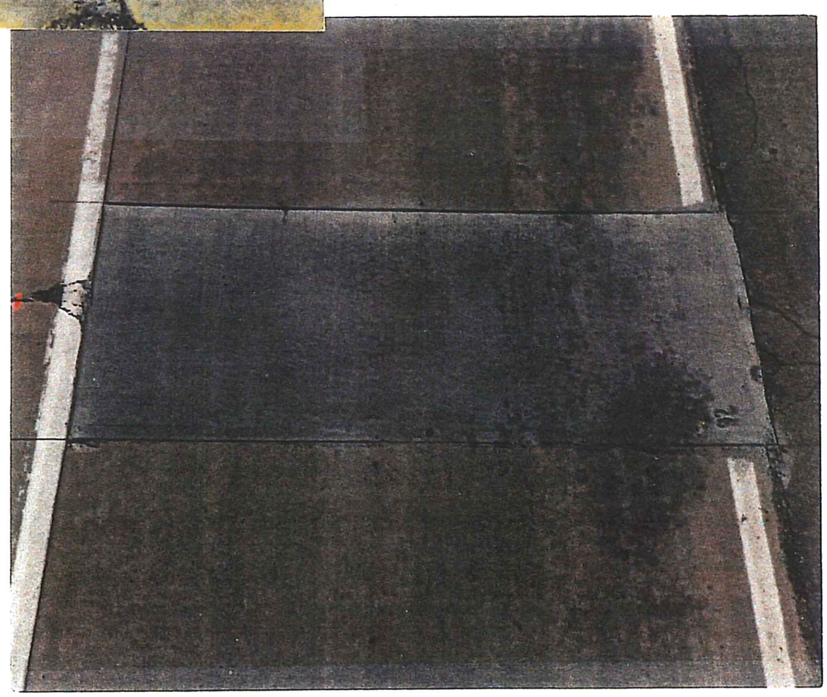


Figure R32.

Severity = 1

Top view of a patch in good condition.

PATCHING

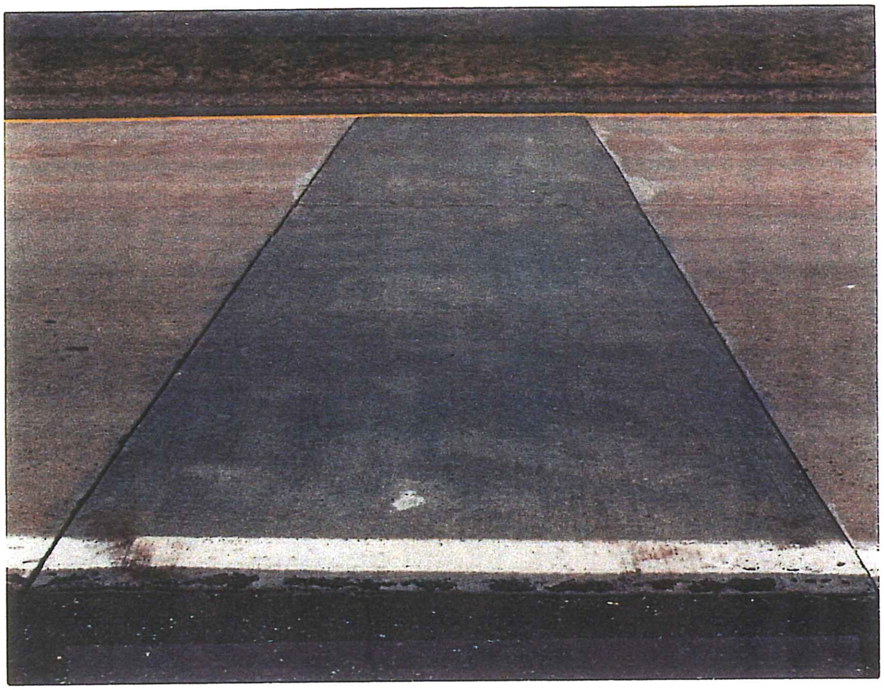


Figure R33.

Severity = 1

This patch is also performing well. Ride quality is not affected.

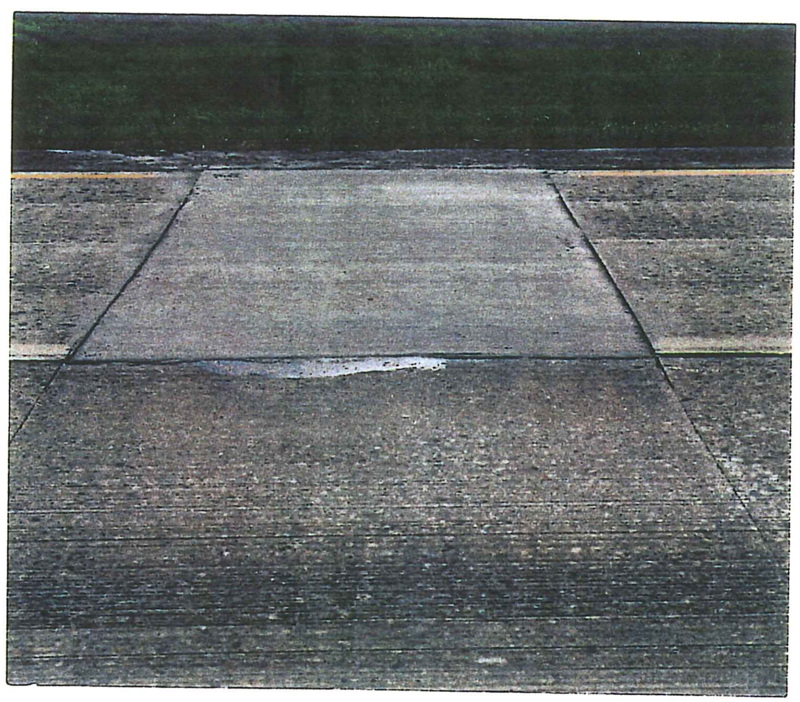


Figure R34.

Severity = 1.

Ground pavements may have new patches in addition to the original (ground) patches. The rating process is similar to unground pavements. The ground pavement is rated as if it were a standard PCC surface.

PATCHING

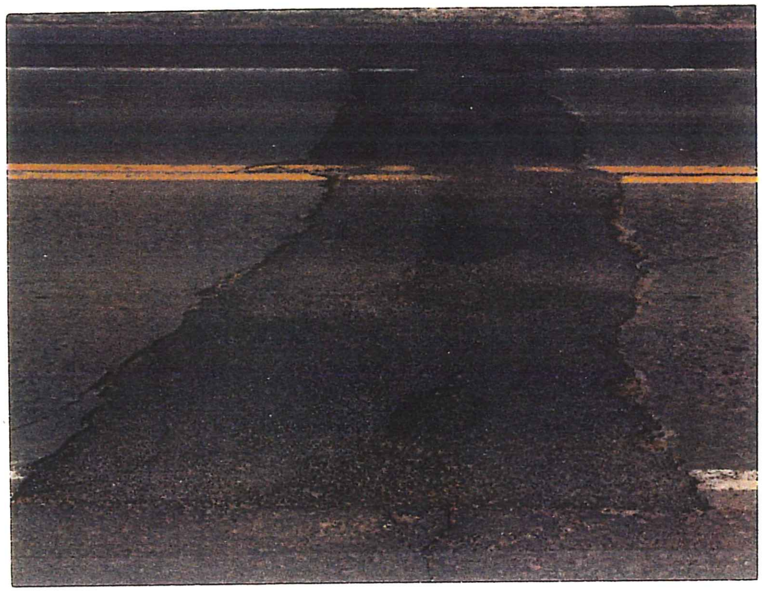


Figure R35.

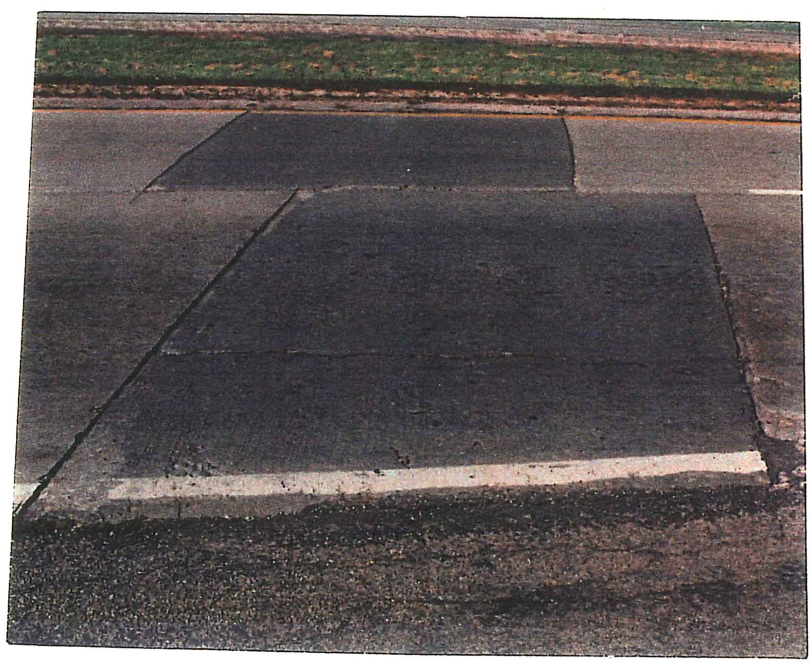
Severity = 2

These AC patches may not be permanent repairs to the PCC Pavement. However, they are rated and appear to be in fair condition. They are somewhat deteriorated and affect ride quality to some extent.

Figure R36.

Severity = 2

This PCC patch is spalled at the edges and has a longitudinal crack running through it. It also appears to have faulted, affecting ride quality somewhat. The patch in the far lane appears to be in good condition.



PATCHING

Figure R37.

Severity = 3

These AC patches are in poor condition. Ride quality is significantly affected, and the patches need to be replaced.

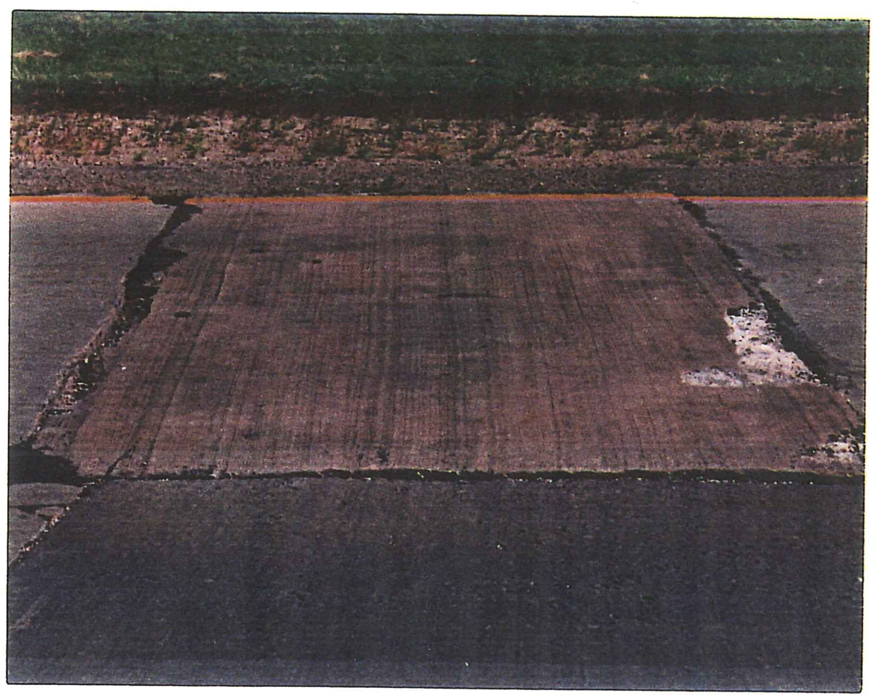


Figure R38.

Severity = 3

This PCC patch is spalled at the edges, especially in the wheel path. Ride quality is severely affected. This patch needs to be replaced over an extended area in order to restore ride quality.

SURFACE DISTRESS

Description: Surface Distress is the cracking, spalling, scaling, crazing[20], breaking, chipping, popout, raveling, or disintegration of the concrete wearing surface within the slab.

Cause: Surface Distress is caused by environmental conditions, improper construction, poor materials, etc. Disintegration or missing pieces, erosion of the surface due to reaction from de-icing materials, repetitive freezing and thawing cycles or weakened surface caused by overfinishing and/or alkali reactions, all contribute to Surface Distress.

NOTE: Exposed or polished coarse aggregate is not a Surface Distress. **Distress within two feet of a crack or a joint should not be considered under Surface Distress.** This area within two feet of a crack or joint is evaluated either under Distressed Joints/Cracks or under Longitudinal Joint Distress.

Severity

Severity rating for surface distress is based on the depth of the distress in the wearing surface.

0 = distress not significant (such as minor cases of crazing)

1 = depth of distress less than 1 inch

2 = depth of distress equal to, or greater than, 1 inch (this level of distress will usually have a patch, especially if in the wheel patch).

Extent

The extent level of surface distress is based on the percentage of the segment area affected.

0 = none

1 = less than 10%

2 = greater than 10%

[20] Map cracking or Crazing refers to a network of shallow, fine, or hairline cracks which extend only through the upper surface of the concrete.

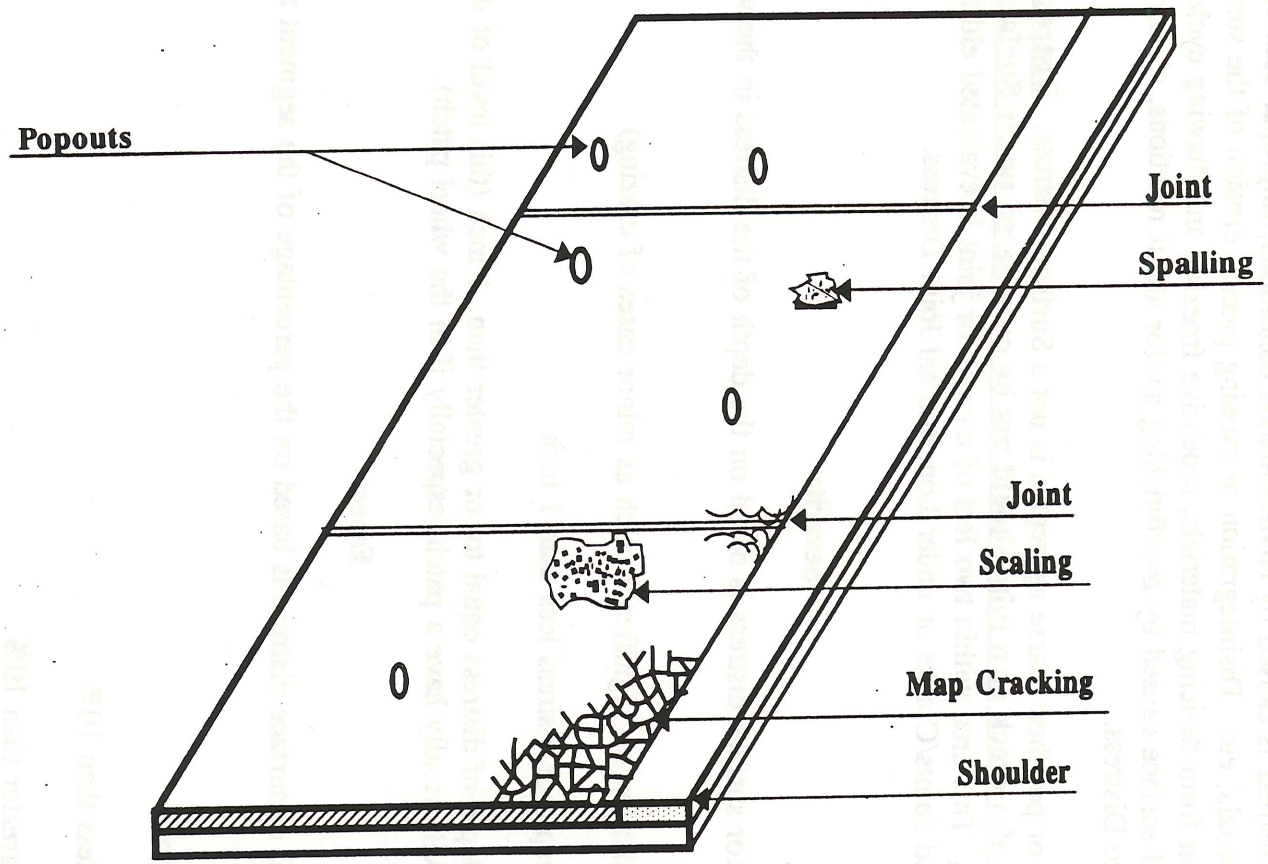


Figure R39. Surface Distress

Surface Distress may include cracking, spalling, scaling, crazing, breaking, chipping, popouts, raveling, and other forms of distress which occur on the pavement surface and are not listed under any of the other PCC categories in this manual.

SURFACE DISTRESS

Figure R40.

Severity = 1 Extent = 1

The pavement wearing surface erodes due to the action of deicing chemicals. The rust stains indicate the reaction to de-icing chemicals.

Figure R41.

Severity = 1 Extent = 1

A ground surface which has broken down, spalled, scaled and disintegrated to form popouts.

SURFACE DISTRESS

Figure R42.

Severity = 2 Extent = 1

Loss of the pavement wearing surface, disintegration of pavement surface due to scaling, erosion of the pavement surface due to action of deicing chemicals, and weakened surface due to overfinishing.

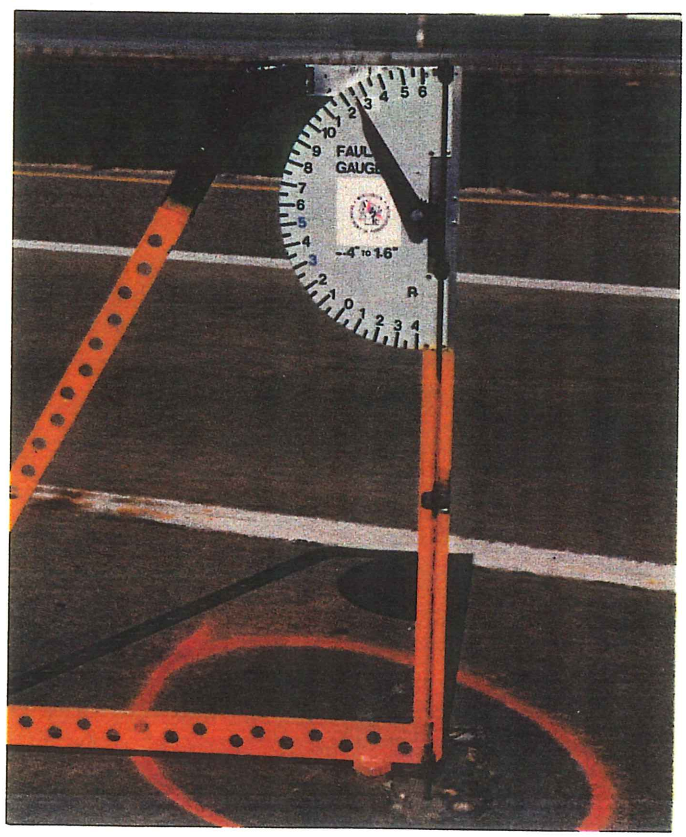


Figure R43.

Severity = 2 Extent = 1

The pavement wearing surface has spalled. The depth of distress is greater than 1 inch.

SURFACE DISTRESS

Figure R44.

Severity = 1 Extent = 2

Fine cracks in the pavement wearing surface caused by an alkali-aggregate reaction. These cracks are generally 1 inch deep. Surface distress severity level is based on the depth of the distress in the wearing surface, i.e., the depth of the cracks.

Figure R45.

Severity = 2 Extent = 2

The depth of the wearing surface missing or deteriorated is one inch. The entire surface appears to be cracked. It also appears that there is an Alkali Silica reaction in this photo.

LONGITUDINAL JOINT DISTRESS

Description: Failure at the Longitudinal Joint[21]. Two factors are considered when rating Longitudinal Joint Distress, i.e. Longitudinal Joint Faulting and Longitudinal Joint Distress.

Cause: Longitudinal Joint Distress is caused by deterioration of the concrete in the immediate vicinity of the longitudinal joint. Longitudinal Joint Faulting is the difference in elevation at the longitudinal joint between two traffic lanes(Pavement Slabs).

Rating

Longitudinal Joint Distress will be assigned severity levels only. Distress within two feet on either side of a longitudinal joint should be rated as Longitudinal Joint Distress. At intersecting cracks and joints, the rater must determine whether the distress belongs primarily to the longitudinal joint or to the intersecting crack/joint. The amount of faulting is determined by measuring the difference between the slabs.

0 = none (no faulting or distress present)

1 = slight (faulting less than 1/2 inch; early stages of distress apparent; slight loss of surface). **Distress less than 2 inches wide.**

2 = moderate (faulting between 1/2 and 1 inch; a general deterioration of the distressed joint with a moderate loss of surface). There is a slight effect on the ride or safety. **Distress between 2 inches and 4 inches wide.**

3 = severe (faulting greater than 1 inch; a significant breakup and loss of the surface resulting in a major effect on ride or safety). This severity includes significant patching. **Distress greater than 4 inches wide.**

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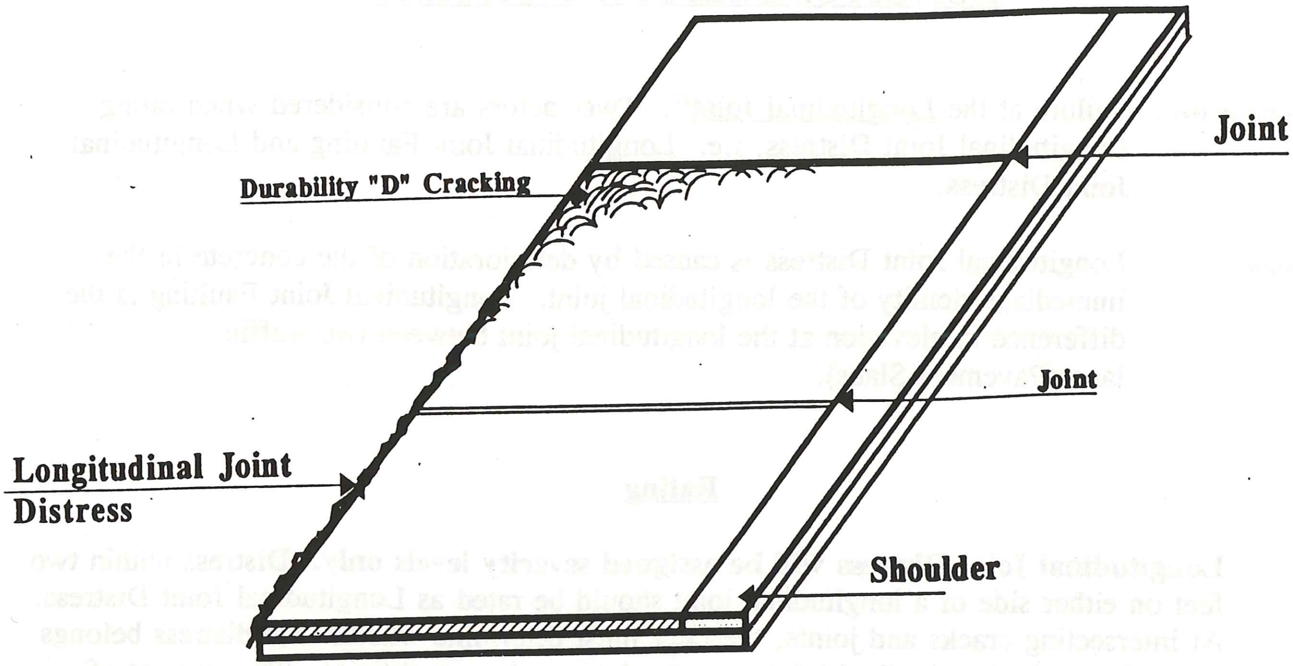
[21] This distress item **does not include Longitudinal Cracks: It refers only to Longitudinal LANE Joints**. Longitudinal Cracks are included under Distressed Joints/Cracks.



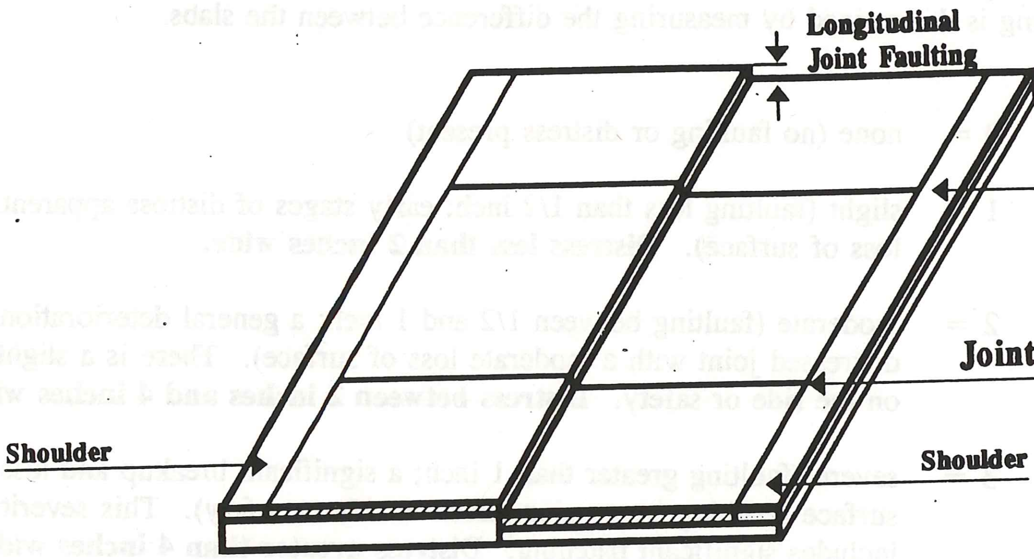


Figure R46. Longitudinal Joint Distress.

This category includes all those distress types associated with the longitudinal lane joints. The area of influence for this distress factor is two feet on either side of the longitudinal joint. Spalling, breaking, and faulting of the longitudinal joint are a few of the distress types that may be evaluated under this category. Longitudinal cracking should be evaluated as distressed cracks unless the crack lies within two feet of the longitudinal Lane Joint.

LONGITUDINAL JOINT DISTRESS

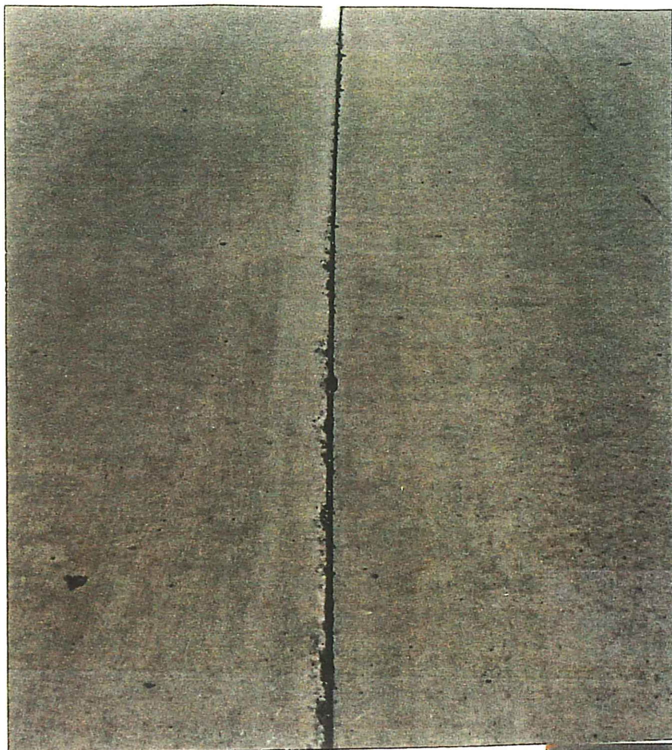


Figure R47.

Severity = 1

The photo to the left shows a longitudinal joint with early stages of longitudinal joint distress.

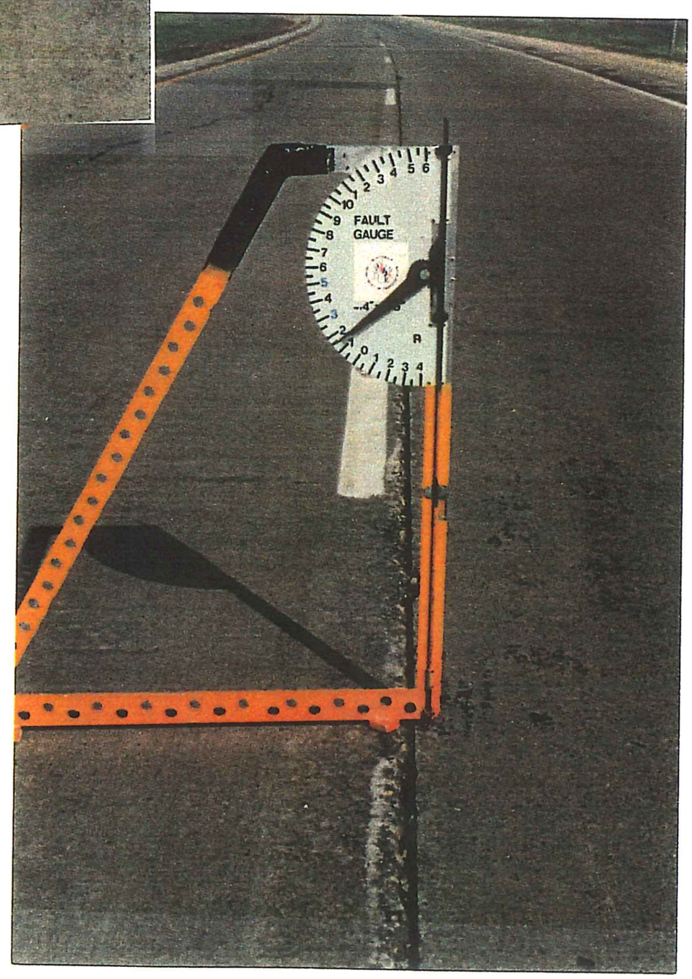


Figure R48.

Severity = 1

The photo on the right shows a longitudinal joint with slight faulting and slight spalling at the joint.

LONGITUDINAL JOINT DISTRESS

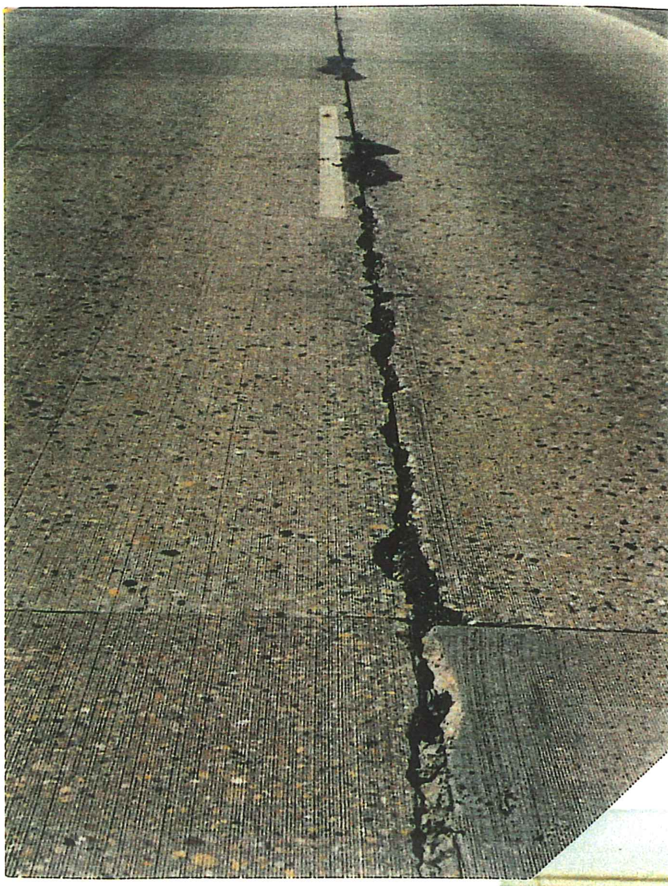


Figure R49.

Severity = 2

This photo shows a longitudinal joint with moderate spalling at the transverse-longitudinal joint intersection.

Figure R50.

Severity = 2

The photo on the left shows a longitudinal joint with moderate amount of material loss.

LONGITUDINAL JOINT DISTRESS

Figure R51.

Severity = 3

The longitudinal joint is broken up and there is some loss of pavement material. Note that the joint is heavily filled with asphaltic material to decrease further breakup and dislodgement of PCC material.

Figure R52.

Severity = 3

Note the significant amount of joint fill material in the longitudinal joint.

TRANSVERSE FAULTING

Description: Differential vertical displacement of abutting slabs at joints or cracks creating a "step" deformation in the pavement surface.

Cause: Transverse faulting is caused, in part by: heaving of one of two adjacent slabs, uneven roadbed support under the slabs, a buildup of material under the approach slab near the joint or crack caused by pumping of free water (under pressure) due to dynamic heavy loading. Lack of load transfer contributes greatly to faulting.

Severity

Faulting severity is determined by measuring the difference in elevation of adjacent slabs at the joints or cracks. Fault measurements should be taken 2 to 3 feet from both the outside and the inside pavement edge(driving and passing lane pavement edges). The severity rating is based on an average fault depth within the survey segment.

0 = distress not present

1 = faulting less than 1/4 inch (average faulting <=1/4 inch)

2 = faulting between 1/4 and 1/2 inch

3 = faulting greater than 1/2 inch (average faulting >1/2 inch)

Extent

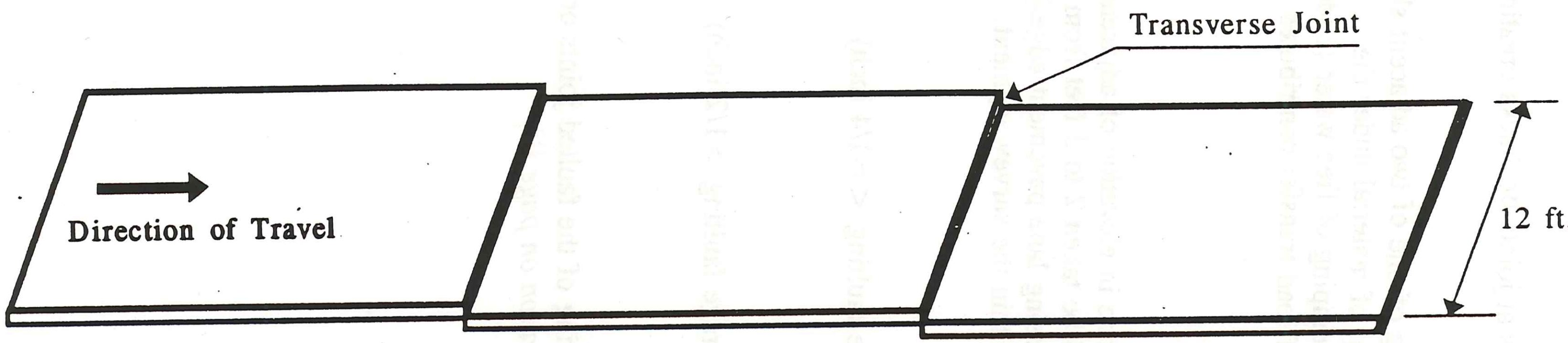
The extent measurements are based on the average spacing of the faulted joints or cracks within one station(one hundred feet). *See illustration on page 98.*

0 = none

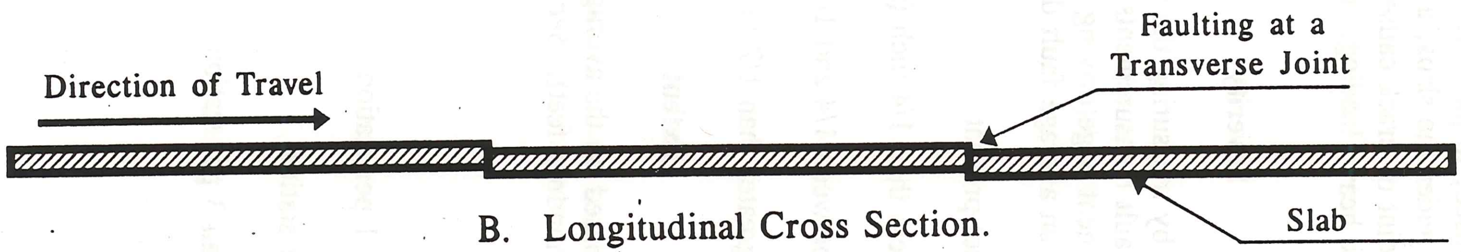
1 = less than 1 per station

2 = 1 - 2 per station

3 = More than 3 per station.



A. View of Faulted Transverse Joints.



B. Longitudinal Cross Section.

Figure R53. Transverse Faulting

Illustration of Faulting in PCC pavements as seen from the perspective and the longitudinal cross sectional view. Notice the "Step Down" in the direction of travel. Faulting measurements are taken 2 to 3 feet from the edge of the pavement slab. The number of faulted joints per station is recorded. Faulting at the joints should be measured across both lanes.

The longitudinal cross section has been exaggerated to highlight transverse faulting.

TRANSVERSE FAULTING

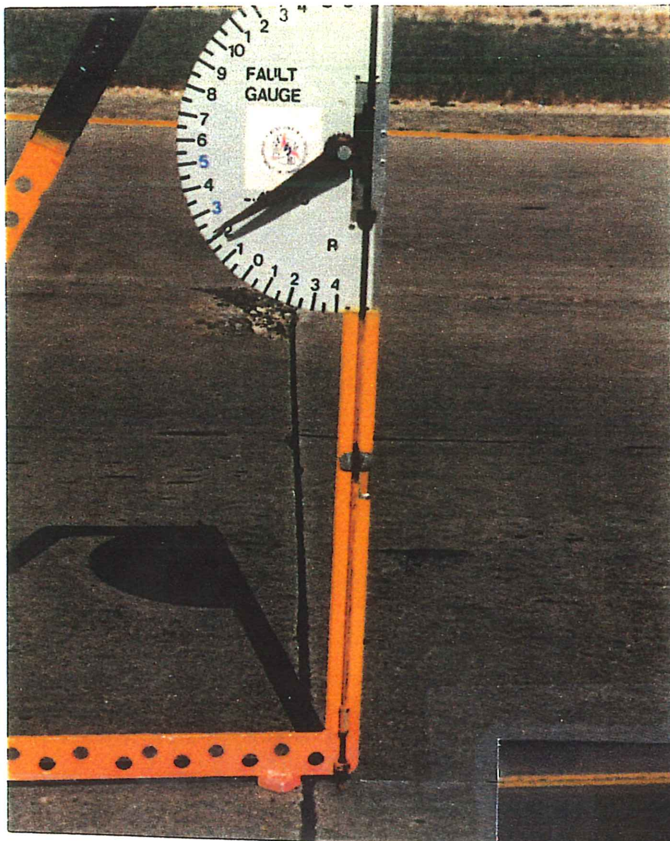


Figure R54.

Severity = 1

The photo on the left shows transverse faulting less than 1/4 inch in depth. Transverse joints show a "step down" in the direction of traffic.

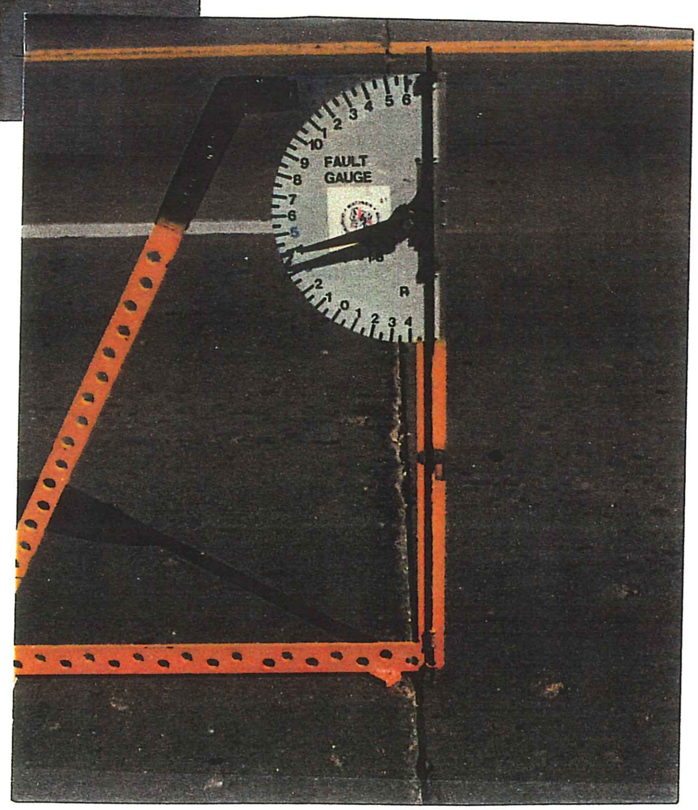


Figure R55.

Severity = 2

Faulting is between 1/4 inch and 1/2 inch in depth. Ride quality is affected slightly. The extent of faulting is based on the number of faulted joints per station.

TRANSVERSE FAULTING

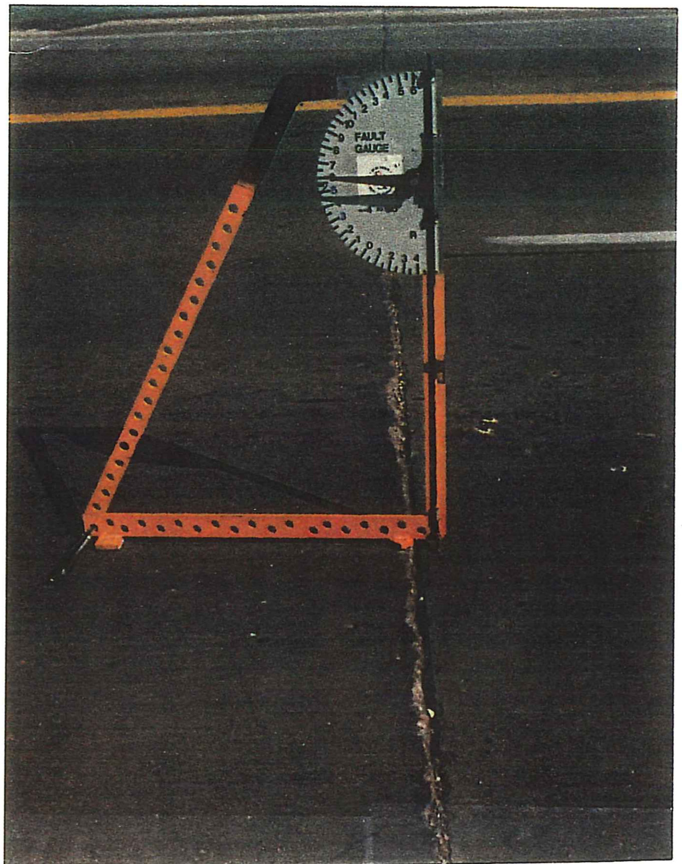


Figure R56.

Severity = 3

The photo on the left shows a faulted transverse joint where faulting is greater than 1/2 inch. Ride quality is significantly affected by faulting this severe, especially if joint spacing is short. Direction of traffic is from left to right.

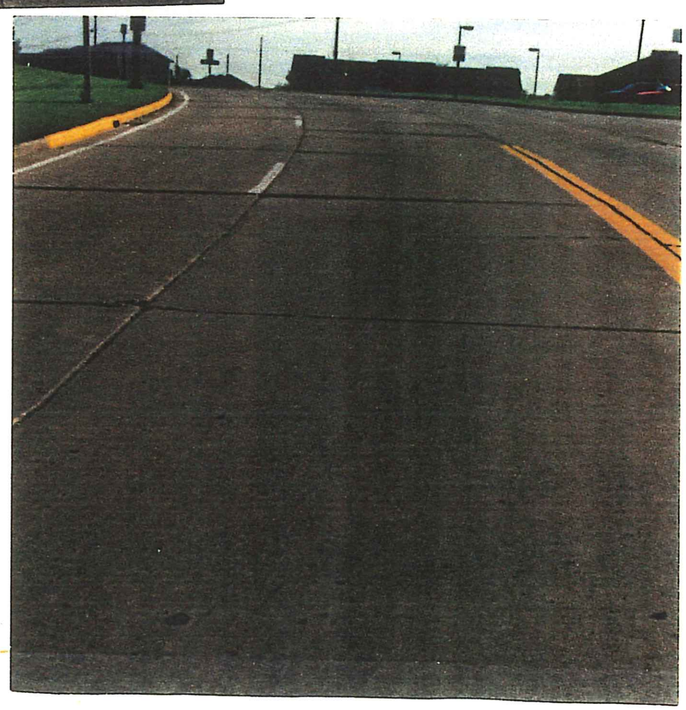


Figure R57.

Severity = 3

A typical faulted pavement when looking in the direction opposite the traffic flow.

CRCP SURVEY

(Identifying, estimating and recording CRC Pavement Distress indicators)

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT(CRCP)

The Wisconsin Department of Transportation constructed the first Continuously Reinforced Concrete Pavements (CRCP)[22] in 1961. At the end of the 1987 construction season, over one thousand four hundred (1400) lane miles of CRCP had been built in the state.

An annual CRCP cracking survey was started in 1973 and expanded in 1975 to include pavement surface distress surveys. The primary objective of the survey effort was to document and study the effects of reinforcing steel in CRCP. Over the years, however, especially since the early 1980's, the scope of the early distress surveys was expanded to cover pavement surface distress identification and analysis. This section explains in detail the survey categories, criteria and procedures that differ from the rigid pavement survey already presented.

In 1987, the WisDOT Division Administrator issued a mandate to modify the PDI survey procedures and weighting factors. The mandate called for the recognition of the various CRCP distress indicators and the subsequent application of appropriate factors and severity levels to these indicators. The Pavement Management Section of Central Office Materials was assigned the responsibility of surveying all CRCP statewide, thus ensuring uniformity, consistency, and repeatability.

<u>CRCP Distress Indicators</u>

The present survey procedure records CRCP distress indicators in as objective a manner as possible. CRC pavement survey is identical to the rigid pavement survey in evaluating some of the distress indicators. Exceptions exist when identifying and recording pavement deterioration, patching, punchouts, wide cracks, and diagonal cracks in CRCP. In addition, **CRC pavement is surveyed on continuous basis, i.e., the entire section, rather than only one-tenth of the section, is surveyed.**

Personnel from the Pavement Management Section conduct annual PDI surveys on all CRCP in the state and on all other pavement types on the interstate system. Information obtained from the PDI survey is entered into the Pavement Information File (PIF) database which is then updated and prepared for data analysis and reporting.

The survey procedure evaluates nine distress indicators in CRCP and requires a crew of two raters trained in CRCP distress survey procedures and techniques. Table C1 below lists the distress indicators evaluated in CRCP. Slab Breakup, Patching, and Transverse Faulting are excluded because they are not rated in CRCP.

---

22 CRCP is pavement without transverse joints at regular or varied intervals, except for the transverse joints near bridges, structures, patched areas, or pavement transition areas.

Patching rating in CRCP replaces Patching in rigid PCC pavements. A comparison of the list in Table C1 below with that shown for rigid pavement in Table R1 page 61 will show the difference.

The survey procedure for distress type 1 through 3 is similar to that for rigid pavement. But the survey procedures for distress type 4 through 9 are different and as such they are explained under <u>CRCP Survey Procedure</u> below. A list of Pavement Surface Distress indicators for CRCP is shown below.

<u>Observable distresses in CRC Pavements.</u>

1. Distressed Joints/Cracks
2. Surface Distress
3. Longitudinal Joint Distress
4. Wide Cracks
5. Punch Outs
6. Diagonal Cracking
7. Pavement Deterioration
8. Patching Rating
9. Delamination

Table C1. CRCP Distress Indicators. Note that all the distress indicators listed above including those for PCC are on the pavement distress inventory data sheet (Appendix J and K).

<u>NOTE:</u>

CRCP rating procedures and computation are shown in Appendix D - CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (CRCP)".

WIDE CRACKS

Description: A Wide Crack is any transverse or diagonal crack over one-quarter(1/4) inch in width.

Cause: Wide Cracks are caused by temperature stresses, fatigue cracking in the pavement, excessive steel[23] stress and/or excessive steel corrosion. The steel has normally ruptured. Transverse cracking of continuously reinforced slabs is a normal occurrence and is a distress considered under pavement deterioration. A crack is rated as a wide crack if the crack width exceeds 1/4 -inch.

Rating

0 = none

1 = there are transverse or diagonal crack(s) greater than 1/4-inch in width (This indicates that the steel has ruptured).

Figure C1

Rating = 1

This CRCP crack is greater than 1/4-inch in width.

---

[23] The purpose of the steel in the pavement is to hold the randomly spaced cracks tightly together so that load transfer across the crack is obtained through aggregate interlock. If the steel ruptures or shears, the load transfer capability of the pavement is lost and the crack becomes a potential location for distress. Indicators of ruptured/sheared reinforcing bars are faulted and/or widened and spalled cracks.

PUNCHOUTS

Description: When two or more transverse cracks (generally spaced approximately 2 feet apart) are linked by longitudinal cracks, a block is formed. The block is called a punchout.

Cause: The section of the pavement between the cracks act like a beam in the transverse direction and longitudinal cracks occur forming a block. Eventually, the action of traffic causes the cracks surrounding the block to spall and fault. Ultimately, the block begins to move significantly causing the steel to rupture. The resulting unconfined block is punched into the base course (often accompanied by further breakup of the block). A punchout that occurs near the edge of the pavement requires only one longitudinal crack to form the block.

Punchouts provide a visual indication that terminal condition has been reached.

Rating

Punchouts are given a yes or no rating.

0 = no, there are no punchouts in the segment

1 = yes, there are one or more punchouts in the segment

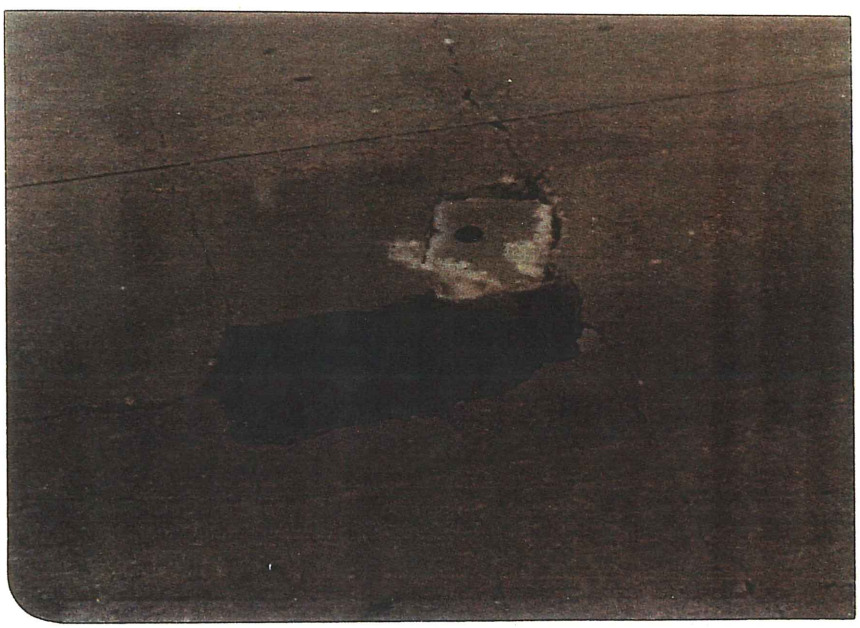


Figure C2.

Rating = 1

This is a typical punchout. Notice that the block of concrete in the center of the picture has been shoved downward(punched out). This shows that the steel has ruptured.

PUNCHOUTS

Figure C3.

Rating = 1

A rating of one indicates that there is a punchout. The photo shows a punchout in the inner lane close to the centerline.

DIAGONAL CRACKING

Description: Diagonal Cracking is a distress indicator used only for rating CRCP. The presence of this distress indicates breakup of the pavement as a result of heavy load repetitions on a pavement with inadequate roadbed support. CRCP is not rated for Slab Breakup because there are no definable slabs.

Rating

Diagonal cracks with widths **over one-quarter** inch should be rated as Wide Cracks.

0 = there is no breakup or diagonal cracking

1 = there is breakup or diagonal cracking

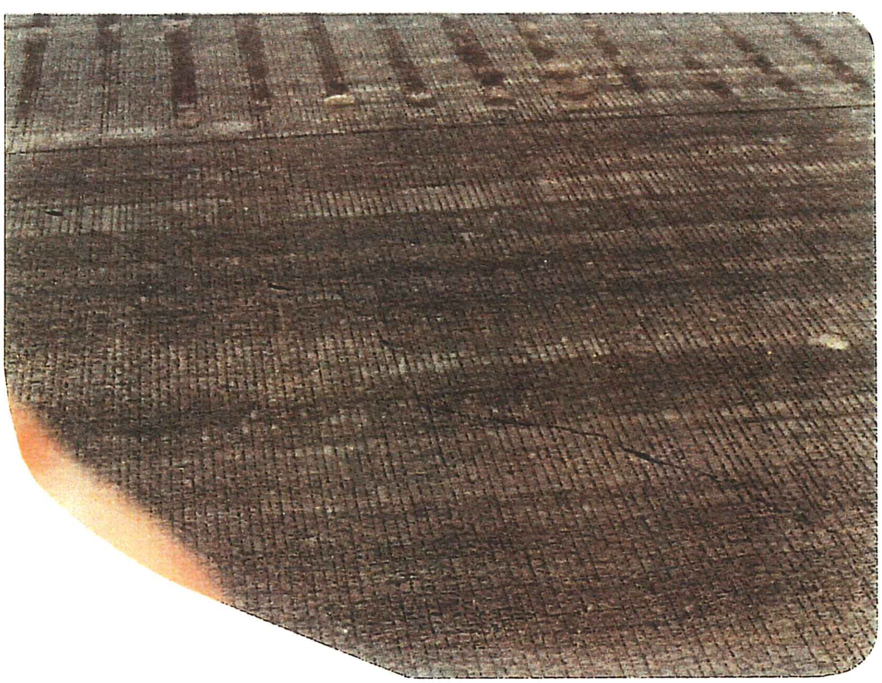


Figure C4.

Rating = 1

A fine diagonal crack in what appears to be a fairly new pavement.

DIAGONAL CRACKING

Figure C5.

Rating = 1

A badly spalled diagonal crack in CRC pavement. Note that the spalls occur at the intersection of the diagonal crack and the transverse cracks.

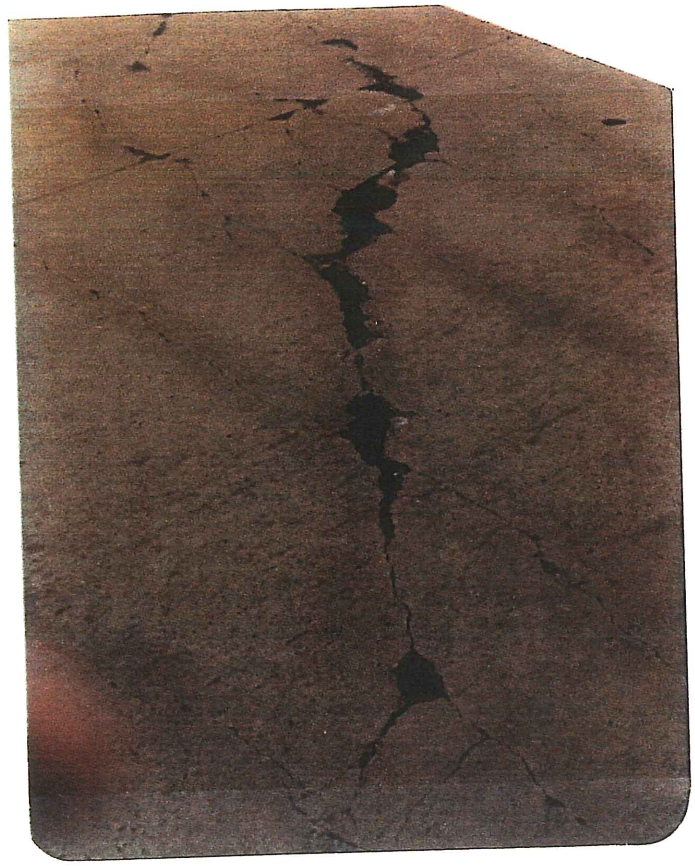


Figure C6.

Rating = 0

The crack width is greater than 1/4-inch so, rate as a wide crack.

PAVEMENT DETERIORATION

Description: Pavement Deterioration is the cracking of the CRCP in such a manner that there is a loss of structural integrity.

Cause: A possible cause of CRCP deterioration is delamination of the concrete at, or near, the level of the longitudinal steel.

Severity

Severity for pavement deterioration is based on an average crack spacing. An average crack spacing is the average spacing of four or more adjacent cracks.

0 = 2 - 8 ft. Transverse cracks spaced an average 2-8 feet (This is normal cracking patten for CRCP). No **fine** (hairline) **longitudinal crack(s)**[24]

1 = Less than 2 ft (Transverse cracks spaced an average less than 2 ft., but no fine longitudinal crack(s))

2 = severity level 0 or 1 along with fine longitudinal crack(s).

3 = interconnecting multiple fine longitudinal and transverse cracks.

Extent

The extent rating is identical to that used for Slab Breakup. The rater estimates the percent of the section area affected by each severity level. Each severity receives a one digit number representing, to the nearest 10 percent, the percent of the section area with that particular severity level. Zeros must be entered in those columns which have no distress at that severity level. The letter "A" should be used when any severity level represents 100 percent. All entries must sum up to 100 percent.

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[24] Fine longitudinal cracks are the result of corrosion of the longitudinal steel. These cracks develop over the longitudinal steel and should be distinguished from longitudinal cracks resulting from other causes. Each of the two lanes evaluated should be considered an infinitely long slab.

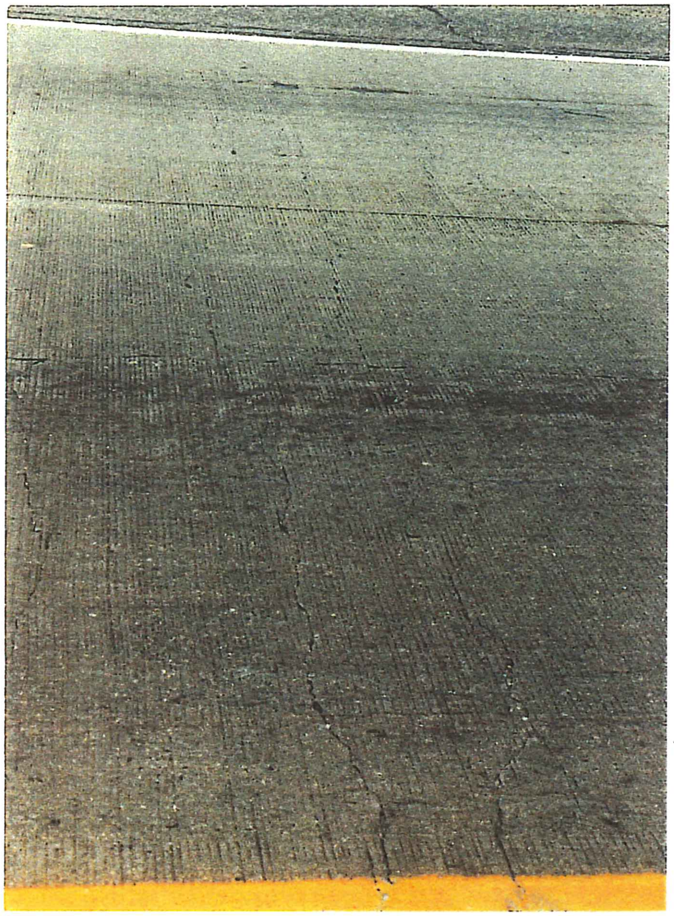

Figure C7.

Severity = 1

A fifty-foot element with this type of crack distribution would be rated as 0. The cracks are spaced about 2-8 feet apart, but there is a fine longitudinal crack along the inside wheel path. The rating goes to 1 due to the fine longitudinal crack.

Figure C8.

Severity = 2

The cracks are very closely spaced. Note that the Y cracks occasionally intersect transverse cracks. A fifty-foot section with this transverse crack pattern would be rated as 2.

PAVEMENT DETERIORATION

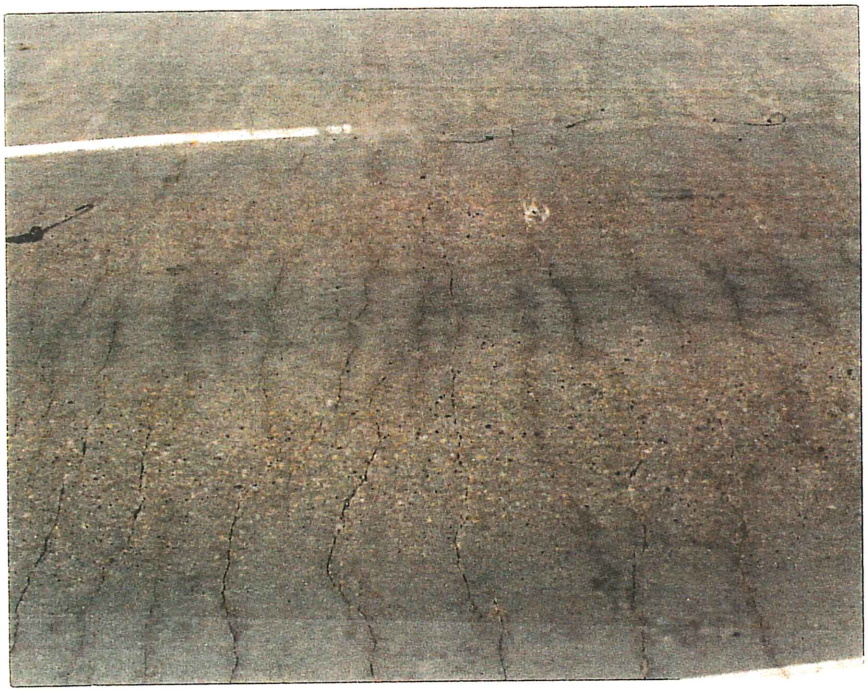

Figure C9.

Severity = 1

A closer look at pavement deterioration where transverse cracks are spaced at less than two feet apart. Note that the cracks are fine and tight. Some of the cracks form Y and are longer than six feet. The Wheel path shows some wear. But generally the pavement is in good condition.

Figure C10.

Severity = 2

This section of CRC Pavement shows three transverse cracks. A closer look, however, reveals that there is a fine longitudinal crack near the centerline. This crack would not be seen if the rater were facing the sun while looking at the distress.

PAVEMENT DETERIORATION

Figure C11.

Severity = 3

The photograph shows the interconnection of multiple fine longitudinal cracks and transverse cracks. The discoloration is due to the rusting of the reinforcing steel. Care should be taken when rating CRCP that appears to be discolored in long longitudinal rows. This color pattern is from snowplow blade (see figure C16 on page 116) and does not represent a distress in CRCP.

Figure C12.

Severity = 3

This entire section of CRCP shows pavement breakup and dislodgement of the concrete at the cracks. Ride quality at this level of distress is significantly affected by the asphaltic material in the wide cracks.

CRCP PATCHING

Description: CRCP patching is a temporary or permanent replacement of original pavement material with either asphaltic concrete or portland cement concrete. Patches may be either partial or full depth; they also may be either partial or full lane. Unpatched areas of pavement breakup and dislodgement greater than 2 square feet in size should be included in CRCP Patching category. Wedging is considered a type of patching.

Cause: Severe punchouts, wide cracks, multiple fine cracks, and pavement breakup and dislodgement, are repaired by patching the pavement.

Extent

CRCP patching rating is based on the percentage of total surface area in a survey section. The percentage is obtained from patching computations made in the office from the work sheet. The extent is determined from the values shown below.

0 = None

1 = Up to 0.24%

2 = 0.25% to 0.49%

3 = 0.50% to 0.99%

4 = 1.00% to 1.90%

5 = 2.00% to 2.90%

6 = 3.00%+

CRCP PATCHING

Figure C13.

This photo shows a deteriorating CRCP patch. The area of the patch is measured (or estimated) and recorded. Severity of CRCP patching is not rated. The extent of Patching is computed. Refer to the Appendix D for details.

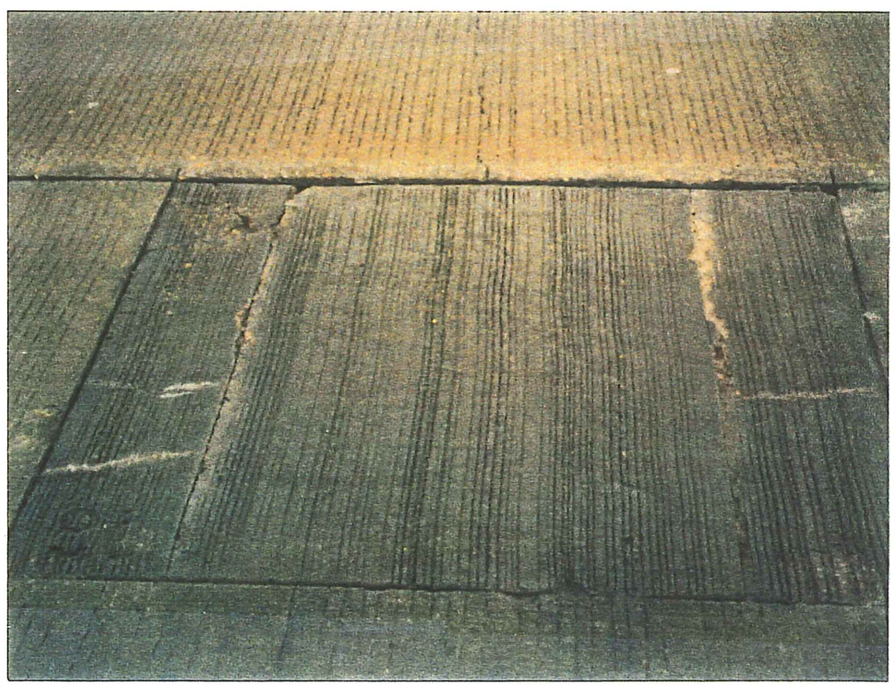

Figure C14.

Record the patched area. All patched or broken up areas (including badly spalled areas) should be estimated and recorded.

DELAMINATION

Description: The peeling or separation of the pavement into layers. The concrete layer above the reinforcing bars peels off from the bottom layer.

Cause: Debonding and subsequent peeling and disintegration of the layers as a result of the action of de-icing salts used in the cold weather months.

Rating

0 = none

1 = there is delamination of the concrete from the steel.

Figure C15

Rating = 1

Delamination exists along the longitudinal reinforcing bars. The rust along the re-bars shows the extent of the delamination.

DELAMINATION

Figure C16

Severity = 0

This section of CRCP shows pavement discoloration due to snowplow blade. This is not a CRCP distress.

APPENDICES

APPENDIX A

DETAILED INSTRUCTIONS

DETAILED INSTRUCTIONS

These detailed instructions deal with properly filling out the AC and PCC Pavement Surface Distress Inventory Data forms. Pavement description information such as, Reference Point (From and To), Section Mileage (Sect Miles), Feature Name (From RP), Mileage to Segment, Surface Year, and Pavement Type, are identical for both types of pavements. This information is reprinted on the inventory data sheet for each district.

Abbreviations used on both forms are self-explanatory. The glossary in this manual provides a detailed explanation on most of the terms used in pavement distress identification. Each distress inventory data form is organized in a manner such that the data can be taken directly from it and entered in the computer.

Common Data.

The County Name and the Highway Number are provided at the top left corner of each form. Next to the county/highway block is a blank block for the survey date. At the top of the survey block is a date format. The date format is used later for data entry into the PIF (Pavement Information File) data base.

At the top right hand corner, blank spaces are provided for the ambient Air temperature and the Recorder/Driver information. The approximate air temperature should be recorded on the top right of the form, as should the initials of the data recorder and Vehicle Operator. This is the only information on the form that is not entered in the mainframe computer. The survey crew fills in the survey data and the Air temperature. The Recorder and Driver initials also should be filled. The data provided at the top of the data form is common for all pavement sections listed on that page. Whenever the County name or highway number changes, a new data form is provided. All the blank spaces at the top of the form must be filled. Pages 162 and 163 show examples of properly and improperly filled forms.

Section Identification.

The Reference Point (RP) entries define the starting (**From**) and ending (**To**) point of each section. The ending point of one section is also the starting point of the next section, i.e., the "To" entry for one section equals the "From" entry for the next section.

The column labeled "RP" represents two entries, the first entry (moving from left to right) shows the "From" RP number and the second entry is the "To" RP number. The column labeled "Sect Miles"contains the length of each highway section. This information is reprinted on the inventory sheet and indicate the length of the section in miles between the "From Rp" and the "To RP".

The Feature Name, contains at most fifteen (15) characters long, including spaces between words. This information is part of the section description and is also reprinted on the form. Normally the Feature Name will correspond to that given in the State Trunk Highway Log, but may be any convenient feature. Survey section lines are often hard or impossible to recognize in the field; thus, they make poor feature names. Sometimes, especially when surveying CRC pavements, it may be beneficial to record the mileage from a known feature to the start of a section. Trying to locate and use a feature that is unrecognizable in the field is not advised. The feature name is the feature corresponding to the "From" RP. Thus, all sections have only one feature name entry, except the last feature entry that has two (the "From" and "To" RP). The starting and ending features of any section can be determined by observing the "From" entry for the section of interest and the "From" entry of the following section.

Columns after the one labeled "Pavement Type" generally require a numeric entry. The exceptions are those columns on the PCC and CRCP inventory data form, that require an alpha entry (A). All columns that require a numeric entry should be filled, e.g., Slab Breakup and Pavement deterioration.

All data fields discussed above are preprinted on the form for you. The crew is charged with filling in the ambient air temperature, Recorder/Driver information and the test date. The entries on these forms should be made from smaller to larger RPs. The RPs occur in increasing order when travelling in a cardinal direction (north or east). The State Highway Log is also organized to show an increasing order of RPs. This does not mean that the survey has to be conducted in the cardinal directions. Since the forms show RPs in increasing order, if the actual survey is conducted in the opposite direction, the surveyor must start filling in the inventory data from the bottom of the form and work upward.

The surveyor should be familiar with locations where two or more numbered highways run concurrently (**Concurrences**). At such locations, the concurrent highways are listed in the Highway Log under one number with the priority for numbering being: Interstate Highways, then U.S. Highways and then State Trunk Highways. When there is a concurrence involving similar type highways, the concurrence number is the lowest numbered highway. Understanding the concurrence concept is essential to properly conduct a survey. Figure 3 on page 123 illustrates the numbering of concurrent highways.

The "Mileage to Segment" refers to the distance from the beginning of the section to the beginning of the survey segment. Figure 2 on page 122 is an illustration of a survey segment within a typical section. This figure also shows how to calculate the mileage to segment when surveying in the non-cardinal
direction.

The mileage to segment distance is normally 0.3 miles. However, this distance may be adjusted to avoid surveying sections that pose a risk due to traffic, lie on structures, etc. The mileage to segment distance ensures that the same one-tenth mile segment in each section is surveyed each time. When surveying a highway in the non-cardinal direction, the surveyor should compute the distance to the end of the segment from the end of the section, and survey one-tenth of a mile beyond this point. The distance to the end of the segment is found by subtracting four-tenth (0.4) from the total section length. The distance computed should be written in the margin on the inventory sheet. The crew surveys one-tenth of a mile and fills in the inventory data sheet. The section so surveyed is the same as if the survey had been done in the cardinal direction. Only one column is allotted for the "Mileage to Segment". The distance in tenths of a mile is preprinted on the data form without the decimal.

Surveying Opposite to Cardinal Direction

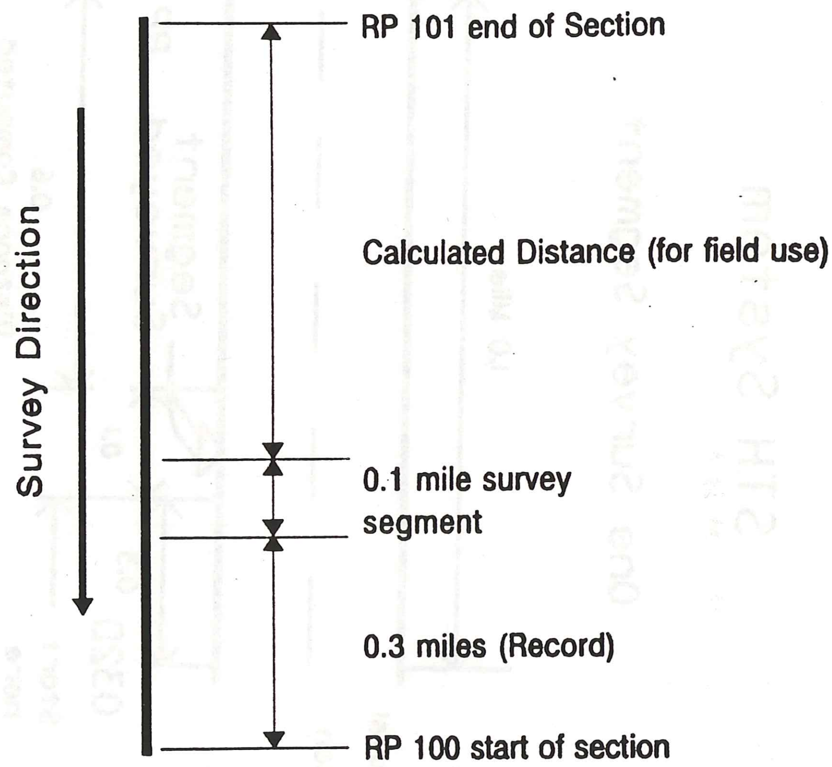

Figure 1.

Distance to record when surveying in a direction opposite to the cardinal direction.

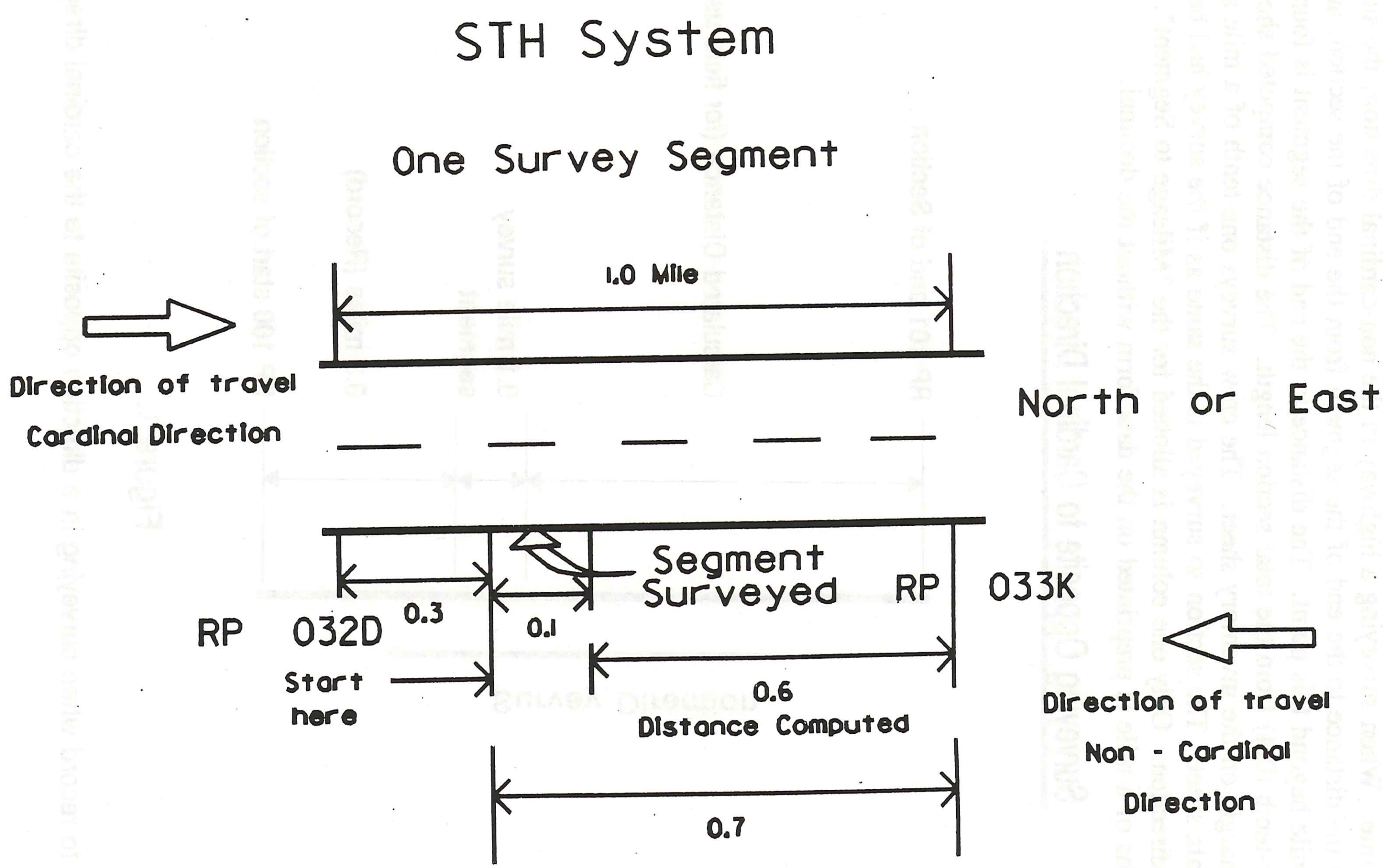

Figure 2 Survey Segment

In this example the survey Segment is assumed to be One Nominal Mile long.

Generally the survey segment will be between 0.4 to 2.00 miles long.

The following example, used with Figures 1 and 2, may help clarify RP and highway numbering when concurrences exist. First, note that RPs increase in the north and east directions. Second, where USH 9 and USH 32 are concurrent the highway is numbered the lowest number. Where USH 9 and USH 32 are concurrent with STH 4 the lowest U.S. Highway number is used. When surveying STH 4 in the cardinal (East) direction, there is a concurrence beginning at RP 16. This section appears in the Highway Log as, "*** HWY CONC ***". The Highway Log also would state "CONC WITH USH 9 FROM RP 45 TO RP 41 FOR "X" MILES." The next survey segment on STH 4 is within the section between RP 17 and RP 18. The sections between RP 41 and RP 50 are part of USH 9. In this example, any survey section between RP 41 and RP 50 must be surveyed as USH 9.

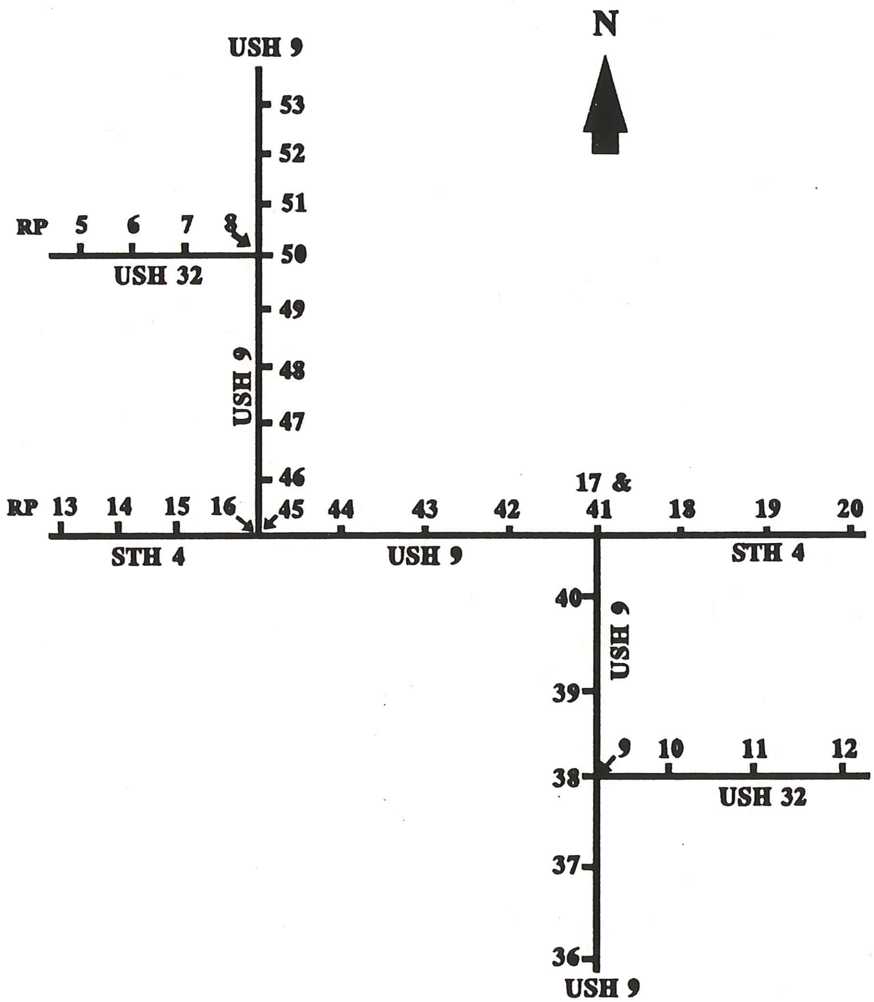

Figure 3. Highway Concurrencies.
Reference Points increase in the North and East direction.

APPENDIX B

<u>PAVEMENT TYPES</u>

PAVEMENT TYPES

At the top of each survey form below the title, is a list of abbreviations for the pavement types. The list below is a summary of the abbreviations used on the forms:

Asphaltic Concrete Pavements

1 = AC/FB	Asphaltic Concrete Pavement Mix over Flexible Base
2 = ARM	Asphaltic Road Mix
3 = AC/RB	Asphaltic Concrete Pavement over Rigid Base.

Portland Cement Concrete Pavements

4 = JRCP	Jointed Reinforced Concrete Pavement
5 = JPCP w/o d	Jointed Plain Concrete Pavement (unreinforced but without dowel bars)
6 = CRCP	Continuously Reinforced Concrete Pavement.
8 = JPCP /d	Jointed Plain Concrete Pavement With dowel bars.

Asphaltic Concrete Pavement Distress Indicators.

The next twelve headings on the AC Pavement Surface Distress Inventory Data form are the eleven distress indicators for AC pavements. Segregation, the thirteenth AC pavement distress indicator, is rated and recorded on the same line as the Remarks row. In small print above the twelve headings, the severity levels for each indicator are shown, see Glossary for a detailed explanation. The first column is labeled "1=Block, 2=Alligator". This column is not a distress indicator. It is filled in whenever Block or Alligator cracking exists. An entry of a zero indicates that no alligator or block cracking was present.

The three categories of cracking have the same severity levels. Severity level 3 for Block/Alligator Cracking, is written over the "Block/Alligator" column and indicates dislodgement. Severity level 3 over the Transverse and Longitudinal columns indicates banded cracking. These severity levels are recorded in an area of the form away from where the other severity levels are recorded to emphasize the degree of distress and the meaning associated with each distress.

Distress indicators that have extent levels, have the various levels listed below the heading. The units of measurements are given below the extent levels. One severity level must be determined for each distress indicator and the number of that severity level must be written in the appropriate extent level. There must be only one entry for each distress indicator. A zero (0) severity can only be placed in a "None" extent level column (there is no distress). The "None" extent level in the PIF system can only accept a zero (0).

Proper AC data form entries are shown on pages 162 and 163. The column labeled "Seal Coat" refers to all types of seal coats, i.e., chip seal, fog seal, or slurry seal. If the surface being surveyed has been seal coated, a one (1) must be placed in this column.
For each survey segment, there are two rows of lines for data entry. The second row is reserved for remarks and the rating for segregation. The rating for segregation should be entered on this row after "SEG=__". Remarks can be alpha or numeric entries and are limited to sixty (60) characters (when entered in the mainframe computer). Remarks should be made for those conditions not covered by the distress indicators, or for any unusual occurrences.

The surveyor will, at times, be called upon to exercise engineering judgment when the actual field condition does not represent any of the distress indicators. For example, if a serious slippage[25] condition is noted, it could either be noted in the "Remarks" section, or, if the surveyor thought appropriate, it could be included with a distress indicator of a similar nature (say Longitudinal Distortion). In the example just given, do not include the same distress in two distress indicators. However, the "Remarks" section should be used to note that the slippage problem was rated as a Longitudinal Distortion distress. This is true for all other distresses. Rating any given distress in more than one distress indicator increases the severity and extent of the distress thus the PDI. To reduce the effect of "double counting", make sure that no distress indicator is rated twice.

There will be times when it will be difficult to determine the actual distress. For an example, early forms of Block/Alligator Cracking often appear as longitudinal and/or transverse cracking. The surveyor will, in time, develop the expertise to distinguish "differing" distress type (categories) from each other. This manual is written to provide the necessary explanation needed to identify and evaluate distress in order to ensure consistency and repeatability. However, all entries must be entered in the appropriate columns on the inventory data forms.

At times a given distress will have two severity levels within the survey segment. For example a transverse crack may be less than one-half inch wide for several feet and in the next several feet, be over one-half inch wide. Unless this manual instructs otherwise, if a higher severity level exists for over 25 percent of a distress, the higher value should be recorded.

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25 Slippage cracks are crescent or half-moon shaped cracks generally having two ends pointed into the direction of traffic. They occur when the braking or turning wheels cause the pavement surface to slide and deform. Slippage is identified by crescent shaped cra[illegible] "pointing" in the direction of traffic. Such cracking is caused by wheel thrusts whi[illegible] shove/tear the surface course.

APPENDIX C

SPECIAL CASES

SPECIAL CASES

AC Distress Indicators

Patching

Any distress associated with a patch is recorded only as the condition of the patch. Deteriorated patches may show disintegration, distortion, cracking, rutting, or spalling compared to the original surface. Distress in the immediate vicinity of the patch, i.e, within one foot of the patch, should be associated with the patch. Occasional patches are small isolated patched areas that do not necessarily constitute a significant amount of the segment length. Any patching less than two percent of the length of the segment would reasonably be rated as occasional. Patching greater than two percent should be rated as less than ten percent of the segment. Large patched areas such as spot overlays and wedged surfaces shall be rated for distress as part of a patch.

Rutting

Rutting is measured three feet from the roadway center line on the inside wheel path. Measurements should be taken at the lowest points and at least five feet from the transverse cracks to minimize the effect of transverse crack distortions. Two rut measurements should be taken, but if the measurements obtained do not agree, a third measurement should be taken. The rating for the section will be the average of the three measurements. Distortion should be rated whenever the inner wheel path rut measurement differs from the outside wheel path rut measurement by more that one-half inch and the outside wheel path rut is greater than one inch deep. Rutting is assumed to cover the length of the survey segment.

Seal Coat

Seal coats obscure distress and therefore affect the PDI. Indicate in the Seal Coat column (1=yes) that a seal coat is recent if no distress is apparent. Unless the Seal Coat masks the distress completely, do not rate it as existing. **A seal coated surface that shows distress should always be rated as zero, i.e., no seal coat. A seal coated AC pavement is rated for all pavement surface distresses.**

Transverse Cracking

The total number of transverse cracks in a survey segment are counted and divided by five stations to obtain the extent rating. Transverse cracks in AC pavements are considered two separate cracks if the distance between them is greater than one foot. A transverse crack is counted if it is at least six feet long or runs across the middle of the lane. Transverse cracks running across the entire roadway width are counted as one single crack.

Maintenance Activities

POLICY 2.30 of the Maintenance Manual "establishes highway maintenance to be a program of activities to preserve, repair and operate the existing state trunk highway system of roadways to its designed or accepted configuration. The state highway maintenance program elements were developed to offset the effects of weather, vegetation growth, deterioration, traffic wear, damage and vandalism. Deterioration shall include the effect of aging, material failures, and design and/or construction faults."

A survey segment may include any or all of the above-mentioned activities. If the pavement is patched or overlaid, but not continuously, then rating of the segment should be based on the original pavement. The distress in the patch or overlay should be evaluated to determine surface condition. If both lanes are continuously overlaid or patched for over 50 percent of the segment length, the original pavement should be ignored and the new segment rated as a new surface. A remark to this effect should be documented, and a change in surface year should be made. All maintenance activities in the survey segment should be documented.

A continuous patch or overlay that covers the entire length of the survey segment shall be rated as a patch. The severity of the patch is determined from the distresses in the patch. Evaluation of the distress in the remaining original surface lane(s), is based on the procedures given in this manual. Refer to the specific distress indicators.

If the patch/overlay is wider than one lane and covers the entire survey segment, the surface shall be evaluated based on the newer AC surface. This should also be noted in the remarks.

Portland Cement Concrete Distress Indicators

The column labeled "Joint Spacing" is reprinted and shows contraction joint spacing in feet. This column accepts only two characters. Therefore a joint spacing of 100 feet or more will be shown as 99, and a random-skewed joint with an average spacing of 15.5 feet will be shown as 16. For pavement type 6 (CRCP), this column will have no entry since the entire section of a CRCP pavement is surveyed. In addition, CRCP pavements have no contraction joint except at the anchor points.

The next fourteen headings on the PCC Pavement Surface Distress Inventory Data forms include the seven (7) PCC distress indicators and an entry for Joint/Crack Filling. In small print above these headings, the severity levels for each indicator are shown (see Glossary). Below the headings where applicable, units of measurement are shown. Those distress indicators which have extent levels list them below the heading.

One severity level must be determined for each distress indicator and the number of that severity level must be written in the appropriate extent level except for Slab Breakup and Pavement Deterioration, which are entered differently as explained below.

All non-CRCP pavements will be rated for all distress indicators except those specifically intended for CRCP. Wide Cracks, Punchouts, Diagonal Cracking, Pavement Deterioration, Patch Rating and Delamination are not rated. All CRCP pavements will be rated for all PCC distress indicators except Slab Breakup, Patching and Transverse Faulting. Patching in CRCP is discussed under **CRCP PATCHING**.

There must be one (and only one) entry for each distress indicator except Slab Breakup and Pavement Deterioration. Slab breakup and pavement deterioration are evaluated by determining how much pavement surface area is affected by any given distress factor (see Slab Breakup Evaluation below). A zero (0) severity can only be placed in a "None" extent level, because the "None" extent level can only accept a zero (0). Proper PCC data form entries are shown on pages 163.

The PCC/CRCP inventory data form also has two rows of lines. The first line is reserved for the distress rating entries. The second line is reserved for remarks. Remarks are limited to 60 characters and may alpha-numeric. Remember, the remarks on the AC and PCC data forms will not be printed out by the computer.

<u>Unless this manual instructs otherwise, if a higher severity level exists for over 25 percent of a distress, the higher value should be recorded.</u>

<u>**Evaluating Slab Breakup**</u>

Slab Breakup is the fracturing of a slab as a result of crack development. When evaluating a slab, the number of blocks in each slab are counted and recorded on a separate work sheet. An example of the work sheet is shown on page 164. The surveyor evaluates the slab in each lane and makes a vertical tally mark in the appropriate column under Slab Breakup on the work sheet. The tally marks are added until a multiple of five (5) is reached. A slash tally mark is then made through the previous four.

At the end of the survey segment, the number of slabs expressed as a percentage of the segment is computed. To save computation time, a table is provided with the approximate percentages computed for you. The percentage of slabs in each column is found by dividing the number of tally marks in each column by the total number of tallies in all columns for the segment. The result is entered in the Distress data inventory form to the nearest 10 percent. For instance, 20% would be approximated to 2, 33% to the nearest 10 % is 3, 57% to the nearest 10% is 6, etc. <u>**The twenty five percent rule does not apply to slab breakup.**</u>

Evaluating Distressed Joints/Cracks

This distress category encompasses all distressed joints and cracks. Longitudinal Joint Distress (center-line joint) is a separate distress category and should not be evaluated here. However, all random longitudinal cracks are evaluated under Distressed Joints/Cracks. Deterioration within two feet of a crack or joint is rated as part of the crack or joint. For example, if two longitudinal cracks are separated by two feet or more, they should be counted as two cracks. For a crack to be recorded, it has to be at least six feet long. The extent levels for both transverse and random longitudinal cracks should be applied for each category.

The surveyor evaluates each slab and places a tally mark for all distressed joints and cracks in the appropriate column under Distressed J/C on the work sheet. The tally marks are placed in the column representing the severity level of each crack or joint. At the end of the segment, the total number of tallies in all columns is computed and divided by 5 to determine the extent level.

After the extent level has been determined, the severity level is computed using the twenty five percent rule. Moving from the most severe to the least severe level, the number of tallies in the most severe distressed column is divided by the total number of tallies. If the number obtained is twenty five or more, the segment is rated at that severity level. However, if the number is less than twenty five percent, the tallies in that column are added to the tallies in the next lower severity level. The percentage is computed as detailed above.

If the result is twenty five percent or more, the segment is rated at this severity level, otherwise the segment is rated as severity level 1 or none. An entry is made on the Inventory data sheet and at this point , Distressed Joints/Cracks rating is complete.

Evaluating Patching

Patching evaluation is similar to distressed joins/cracks evaluation. Each slab is evaluated and a tally mark made in the appropriate column under Patching on the work sheet. The condition of the patch together with the condition of the pavement within two feet of the patch indicate the severity level of the patch. The extent is determined from the number of patches with the segment. The twenty five percent rule is applied and percentage computation done as in Distressed Joints/Cracks. See evaluating Distressed Joints/Cracks above and Examples on page 163 through 164.

APPENDIX D

<u>CONTINUOUSLY REINFORCED CONCRETE PAVEMENT(CRCP)</u>

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT(CRCP)

CRCP Survey Procedure

For CRCP distress survey purposes only, the roadway is subdivided into a large number of fifty-foot survey segments. Each segment is bounded at the beginning by the start of the centerline stripe and at the end by the start of the next centerline stripe. Each segment constitutes a finite survey element to be evaluated for pavement deterioration by the survey crew.

The roadway is surveyed by two trained raters traveling in a vehicle (preferably a Van) on the right hand shoulder at a speed of approximately 5 miles per hour. The driver keeps a tally of the average transverse crack spacing in each fifty-foot survey element on a bank of mechanical counters. He may also note punchouts, and wide cracks. When the entire section has been surveyed, the quantities are transferred to the work sheet, and the counters are reset.

The passenger, who sits on the back seat behind the driver, notes all other distress indicators within the section. Severity and extent levels of all other distress indicators are evaluated and recorded directly in the appropriate columns on the PCC Inventory Data Sheet. The distribution of evaluation duties may be made in the field by the crew. The passenger also estimates and records the area of patches or of broken-up pavement surface.

The Survey Form

The volume of data collected makes it necessary to use separate forms and work-sheets to record the raw data for pavement deterioration and patching during CRCP surveys. Copies of various survey forms are shown in Appendix K. This work-sheet is used for recording estimated patch areas and the various categories of pavement deterioration.

Data for all of the distress indicators surveyed for CRCP except pavement deterioration and CRCP patching, are entered directly on the standard PDI survey form. Distress types 7- (Pavement Deterioration) and 8- (Patch Rating) are recorded on the CRCP work-sheet for further computation in the office. Although the data sheet used for both PCC and CRCP is the same, the columns marked "Slab Breakup", "Patching", "Transverse Faulting", and "Rutting", should be crossed out when surveying pavement surface distress for CRCP. See page 169 and the work-sheet on page 170.

Illustrations and typical photographs of each distress type are provided to aid in distress identification. Guidelines for distinguishing between severity levels of individual distress types are presented and explained under each distress type.

Evaluating Pavement Deterioration

Pavement Deterioration is the cracking of the CRCP such that the structural integrity of the pavement is lost. Pavement deterioration in CRCP is identified, evaluated and tallied under one of the four categories shown below.

1) Transverse cracks are spaced between 2 ft. and 8 ft apart.
2) Transverse cracks are spaced less than 2 ft. apart
3) Fine Longitudinal crack(s)
4) Multiple fine longitudinal cracks and transverse cracks.

Crack spacing is the average distance between transverse cracks. The four categories shown above provide the percent of the section that is under different types of cracking pattern. All transverse cracks that are longer than six feet are recorded. Transverse cracks that join to form Y-cracks should be considered as two separate cracks if both cracks are 6 feet or more in length. Distress at the cracks (such as spalling) is rated under the distressed joints/cracks category or as a wide crack.

To evaluate pavement deterioration, each 50-foot survey segment is evaluated by the driver (using the centerline stripe as guide) and recorded by severity level on the bank of mechanical counters.
As explained above, each of these survey segments are bounded at the beginning by the centerline stripe and at the end by the beginning of the next stripe. The severity level assigned to each segment is the worst severity level present (in all lanes) for most of the length (50 ft.) of the segment.

Note: **In borderline situations, the twenty five percent rule is applied.** When the entire section has been surveyed, the total count for each pavement deterioration category is entered in the appropriate column on the CRCP work-sheet. The counters are reset to zero before resuming surveying. This process is repeated for each section.

Evaluating Patching

Patches are temporary or permanent repairs to a damaged pavement. Patches are used to repair severe punchouts or severely broken pavement areas. Patches may be: partial or full depth, partial or full lane, and either asphaltic concrete or portland cement concrete. The size of the repair or pavement breakup is estimated and recorded in the work sheet (see page 170).

Patch evaluation involves estimating the size of the patched or broken-up areas, two or more square feet in size, and recording the area in the work-sheet. It is recommended that the raters practice guessing the size of a patch and compare it to the actual measured size.

Occasional random measurements should be taken during the course of the day to calibrate rater observations. The ability to estimate the size of a patch will improve as each rater becomes more familiar with CRCP rating.

Given the amount of data and staff time involved, it is not possible to measure each patch to the nearest tenth foot. Patch area estimations, if performed consistently and calibrated frequently, may be used without significantly compromising the accuracy of the data. **Vehicle height, speed, light and pavement condition affect judgement in all aspects of CRCP evaluation including patch size estimation.** The crew may wish to change the direction of travel to optimize surface distress evaluation.

Evaluating Punchouts

Punchouts are either present in a section (rated as 1), or they are absent (rated as 0). The severity and extent of punchouts are not recorded. However, the presence of punchouts has a large effect on the Pavement Distress Index which is calculated from the distress survey data. Care must be taken when rating punchouts since severe pavement breakup (spalling) may resemble a punchout. The photographs provided in this manual provide clear illustrations of punchouts and should be consulted whenever the possibility that punchouts are present exists.

OFFICE COMPUTATION PROCEDURE

Pavement Deterioration

a) **Determine the number of 50-foot segments surveyed within a section.** All severity levels of pavement deterioration are summed on the work-sheet. The value obtained is entered in the column marked "**Length of CRCP**".

b) **Compute the percentage of the section rated at each severity level.** The percent of pavement deterioration is obtained by dividing the value within each column by the length of CRCP (obtained above) and multiplying the result by 100.

c) **Record percentages.** The percentage obtained is recorded on the standard PDI Inventory data sheet (survey form). Use the format that is used for recording Slab Breakup percentage in PCC distress surveys.

Patching Computation

a) To evaluate CRCP patching, the estimated <u>areas</u>[26] of patching, pavement breakup and pavement dislodgement are recorded on the work sheet. The total patched area within a section is the summation of all areas recorded for that section. The percentage of CRCP Patching is computed by dividing the total area patched within a section by the total paved roadway surface area of the section. The total roadway surface area is the section length (feet) multiplied by the roadway width. The expression below illustrates the patch computation.

$$\%\ \text{Patched area} = 100 * \left[\frac{\text{Total Patched/Broken Area}}{\text{Section Mileage} * 5280 * \text{RoadWay Width}}\right]$$

b) **Assign the appropriate extent code.** Once the percentage of CRCP patching within a section has been determined, an appropriate extent code is selected from page 113 and entered on the standard PDI survey form in the column marked "**<u>% Patching</u>.**"

Data Storage

The data collected is recorded on field sheets and on the separate work-sheet (*See Appendix J and K*). Final computations are performed in the office to reduce the data on the work-sheet to a format that is entered on the standard PDI Inventory Data Sheet. The Inventory data sheet is completed and checked before the values are entered into the mainframe. For any given section, all entries on the data sheet should be completed before the next section is surveyed.

Pavement surface distress survey procedures include the following steps for data collection and data entry.

a. Record various distress indicator severities on the field sheet under the appropriate extent levels.

b. Edit and compute patch rating and cracking percent in the office; determine severity levels and fill out the inventory data sheet.

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26 The minimum allowable patch is 2 square feet. Patches smaller than two square feet are not considered under this categories. However, they should be rated under surface distress.

c. Enter the data from the Inventory Data Sheet to the mainframe computer (*See discussion on PIF*).

d. Store the original survey sheet for future reference.

e. Analyze, transform, and report the data using SAS or any other software - e.g., PMDSS or SYSTAT.

Once the data has been collected and stored as outlined above, summaries need to be made in order to report the PDI values and analyze the data. The data as stored on the mainframe is hard to use and hard to understand for reporting and analyzing purposes. Survey data may be extracted from the mainframe and used to build data sets for analysis and reporting using such software as SAS (mainframe or PC), SYSTAT (PC) or PMDSS (work-station/Minicomputer). SAS and SYSTAT are strong statistical analysis packages; while PMDSS is an expert system providing database management, system analysis and decision support functions based on captured expertise and standard database/GIS tools. For details on the operation of PMDSS, the PMDSS User and Tutorial manuals should be consulted.

APPENDIX E

PAVEMENT DISTRESS INDEX

PAVEMENT DISTRESS INDEX

The results of a pavement surface distress survey are used to calculate the Pavement Distress Index (PDI). PDI is a mathematical expression for pavement condition rating keyed to observable surface distresses. The PDI of a segment is a single number that summarizes the level of distress within the survey segment. PDI reflects the composite effects of various distress types and is used primarily for network-level evaluation with minor application to project-level analysis. (Note that at the project level, individual distress observations are of much greater value than PDI in determining present condition and treatment strategy.)

The PDI was developed to combine all pavement surface distresses into a single Index to supplement ride quality measurements (PSI) in evaluating highway condition and performance. The use of a single Index for highway pavement condition also enhances sharing of a common pavement performance data base by the various units within Wisconsin Department of Transportation.

The analysis procedure used to compute PDI accounts for the relative importance of the various distress indicators by assigning appropriate distress factors (weighting factors). PDI is used for ranking highway sections of similar pavement types and construction year. When used with the PSI, network level screening and assessment of pavement performance can be done.

The PDI is based on a multi-attribute multiplicative model. Each factor (attribute) has ceiling constants for various levels of severity and extent. The constants have been adjusted (scaled) to reduce the impact of any one distress on the PDI. The index is an algebraic result of the following expression:

AC **PDI = 100 * (1-(ALCR/BLCR * LCR * TCR * PT * FL * ER * SR * RT * LDT * TDT))**

PCC **PDI = 100 * (1-(SLBRK * DJNT * PATC * SUFD * LDIST * TRFL))**

There are 11 independently rated distress factors for both AC and CRC pavements. Only seven of the CRCP factors are used for rating PCC pavements. Crack Filling, Seal Coat and Segregation are not included in the expression for PDI, but are rated to provide information. All the factors rated are considered to represent the complete pavement distress.

The factors used in the distress survey can be subdivided into those factors causing structural failure and those that are superficial. However, this manual deals with pavement surface distress identification and does not therefore cover structural adequacy of a pavement structure. In order to better illustrate the PDI computation, several examples are provided below.

Example 1. AC Pavement (RP 298D-299G, page 162)

The following data was obtained from an actual asphaltic concrete PDI survey. The values represent the rating as entered on the pavement distress inventory data sheet.

Abbreviation	Distress indicator(factor)	Severity	Extent
ALCR/BLCR	Alligator/Block cracking	= 0	
TCR	Transverse Cracking	= 3	1-5/sta
LCR	Longitudinal Cracking	= 1	101-200
PT	Patching	= 0	
FL	Flushing	= 0	
ER	Edge Raveling	= 0	
SR	Surface Raveling	= 0	
RT	Rutting	= 1	
LDT	Longitudinal Distortion	= 0	
TDT	Transverse Distortion	= 0	
	Segregation	= 0	
	Seal Coating	= 0	
	Crack Filling	= 1	

If any of the rating value is zero (0), the entry in the formula is unity (1). A distress factor[27] representing the severity and extent is used to compute the PDI.

PDI = 100 * (1-(1 * 0.727 * 0.867 * 1 * 1 * 1 * 1 * 0.842 * 1 * 1))
PDI = 100 * (1-(0.531)
PDI = 100 * (0.469)
PDI = 46.9 PDI approx. = 47

PDI values for AC pavements are affected by seal coat and crack filling, both of which hide the severity of the distress. Cracks that are adequately filled are given a rating of 1 (one). This rating may lower the severity. The resultant factor is large indicating less distress and therefore a lower PDI. The factors used in the expression above are obtained from pages 142 and 143 by first determining a Severity column and reading the value at the intersection with an Extent row.

[27] Distress factors are listed on page 8 for all the distress indicators for the three major pavement types in this manual, i.e., AC, PCC, and CRCP.

Example 2. PCC pavement (RP 119M - 120D, page 163)

PDI = 100 * **(1-(SLBRK * DJNT * PATC * SUFD * LDIST * TRFL))**

NOTE: Factors for Wide Cracks, Punchout, Diagonal cracking, Pavement deterioration, and CRCP patching are entered as unity because CRCP and PCC are treated separately in the computation of the PDI.

Abbreviation	Distress indicator(factor)	Severity	Extent
SLBRK	Slab Break up	= 1, 8, 1, 0, 0	all
DJNT	Distressed Joint/Cracks	= 0	
PATC	Patching	= 1	1-3
SUFD	Surface Distress	= 1	<10
LDIS	Longitudinal Joint Distress	= 0	
TRFL	Transverse Faulting	= 1	LT 1/STA

Determine Slab Breakup factor:

1-0.95*(1-(None*(2-3blk)*Additional*Fragmented*Movement))

1-0.95*(1-(1*0.896*0.969*1*1) = 0.875

The factor obtained from the expression above is used in the expression below to compute the PDI

PDI = 100 * (1-(0.875 * 1 * 0.938 * 0.972 * 1 * 0.966))

PDI = 100 * (1-(0.770)

PDI = 100 * (0.229)

PDI = 22.9 **PDI approx. = 23**

DISTRESS FACTORS FOR ASPHALTIC CONCRETE PAVEMENTS

71090 / Seg

Flushing

	Severity 1	2
No Extent	0.956	0.800

Edge Raveling

	Severity 1	2	3
No Extent	0.916	0.798	0.580

Surface Raveling

	Severity 1	2	3
No Extent	0.962	0.914	0.800

Rutting

Severity 1	2	3
0.842	0.542	0.210

Block Cracking

Extent % of Area	Severity 1	2	3
10-24	0.832	0.723	0.622
25-49	0.756	0.622	0.488
50-74	0.672	0.538	0.345
75	0.572	0.437	0.160

Alligator Cracking

Extent % of Area	Severity 1	2	3
10-24	0.658	0.559	0.415
25-49	0.577	0.469	0.316
50-74	0.505	0.388	0.190
75	0.370	0.253	0.100

Transverse Cracking

Extent % No./Sta.	Severity 1	2	3
1-5	0.935	0.838	0.727
6-10	0.831	0.727	0.558
11+	0.721	0.591	0.350

Longitudinal Cracking

Extent LF/Sta.	Severity 1	2	3
1-100	0.930	0.853	0.734
101-200	0.867	0.769	0.615
301+	0.706	0.587	0.300

Patching

Extent LF/Sta.	Severity 1	2	3
Occas	0.962	0.908	0.792
LT 10%	0.908	0.799	0.654
10-25%	0.861	0.669	0.484
25%+	0.777	0.530	0.230

Not Rated

Longitudinal Distortion

Extent % Length	Present 1	Absent 0
1-24	0.766	1.000
25-49	0.504	1.000
50+	0.270	1.000

Nat'l Rated

Transverse Distortion

Extent	Present	Absent
% Width	1	0
1-24	0.808	1.000
25-49	0.609	1.000
50+	0.380	1.000

DISTRESS FACTORS FOR PORTLAND CEMENT CONCRETE PAVEMENTS

Jointed

Distressed Joint/Cracks

No./Sta	Severity Slight	Mod.	Sev.
1-2	0.933	0.805	0.475
3-4	0.835	0.655	0.370
5+	0.768	0.565	0.250

Jointed

Patching

Extent No./Seg.	Severity Good	Fair	Poor
1-3	0.938	0.828	0.676
4-6	0.897	0.717	0.552
7-9	0.848	0.648	0.448
10+	0.814	0.572	0.310

Jointed

Surface Distress

Extent % of Seg.	Severity LT 1 in.	GT 1in.
LT 10%	0.972	0.916
GT 10%	0.884	0.800

Longitudinal Joint Distress

Severity Slight	Mod.	Sev.
0.954	0.861	0.760

Jointed.

Transverse Faulting

Extent No./Stat	Severity LT 1/4	1/4-1/2	GT 1/2
LT 1	0.966	0.932	0.844
1-2	0.939	0.864	0.782
GT 3	0.891	0.793	0.660

CRCP

Wide Cracks

	Rating
Yes	0.800
No	1.000

CRCP

Punchouts

	Rating
Yes	0.590
No	1.000

CRCP

Diagonal Cracking

	Rating
Yes	0.800
No	1.000

CRCP Patching

Rating						
none	1	2	3	4	5	6
0.865	0.730	0.550	0.370	0.190	0.100	

CRCP

Pavement Deterioration

Extent LF/Sta.	Severity 1	2	3
Occas	0.962	0.908	0.792
LT 10%	0.908	0.799	0.654
10-25%	0.861	0.669	0.484
25%+	0.777	0.530	0.230

CRCP

Patch Rating

Extent % Length	Severity Present 1	Absent 0
1-24	0.766	1.000
25-49	0.504	1.000
50+	0.270	1.000

Jointed

Slab Breakup

SEVERITY	Extent %	None	2-3 lg. slab	Additional	Fragmented	Movement
	1		0.988	0.969	0.929	0.816
	2		0.979	0.943	0.858	0.600
	3		0.968	0.912	0.788	0.200
	4		0.957	0.881	0.705	0.200
	5		0.944	0.846	0.593	0.200
	6		0.931	0.811	0.516	0.200
	7		0.920	0.789	0.410	0.200
	8		0.896	0.714	0.410	0.200
	9		0.869	0.639	0.410	0.200
	A		0.840	0.560	0.410	0.200

NOTE: The factor for Slab Breakup is computed from the following expression:
SLBRK= 1-0.95*(1-(2-3lg*Add*Frag*Move))

CRCP

Pavement Deterioration

	Extent %	2-8	<2	Fine Long.	Multiple
	1		0.993	0.837	0.787
S	2		0.982	0.945	0.658
E	3		0.971	0.689	0.580
V	4		0.957	0.643	0.524
E	5		0.939	0.612	0.496
R	6		0.910	0.576	0.468
I	7		0.878	0.546	0.451
T	8		0.845	0.526	0.446
Y	9		0.779	0.500	0.446
	A		0.640	0.490	0.440

NOTE: The factor for Slab Breakup is computed from the following expression:

PVTDT= 1-0.95*(1-(LT2*FLong*Mult))

(LT2 = less than 2, FLong = Fine Longitudinal, Mult = Multiple fine cracks)

APPENDIX F

PAVEMENT INFORMATION FILE SYSTEM

PAVEMENT INFORMATION FILE SYSTEM

General

The Pavement Information File (PIF) System is a computer based data storage system. Pavement Management maintains and updates the files on this system. Special permission is granted to the district personnel charged with PDI survey. District personnel can only access the PIF system to enter the data collect and retrieve pavement performance information. Historical ride quality data is available since 1980. PDI historical data is also available but only since 1985.

Special extraction programs have been written and are available from district data managers and pavement management staff. Upon completion of the PDI survey, the distress information collected should be entered into the main frame computer as soon as possible.

Data Entry

Log on to the mainframe under CICS. Enter your pass word. At the prompt type **dot.hwy.pif**. The main menu in PIF will appear. Select the appropriate letter. The screen will have three choices, choose the one you want.

Data Extraction

PDI historical information can be obtained by running SAS programs that have been developed for this purpose. Listed below are some of the SAS programs available. Theses programs have been updated from SAS version 5.18 to SAS version 6.07.

1. DOFLEXPDI: Flexible PDI data for a selected district and survey year(s). Use this program to check input survey data for flexible pavements.

2. DORIGIDPDI: Rigid PDI data for a selected district and survey year(s). Use this program to check input survey data for rigid pavements.

3. DOPIFHIST: This program will provide both PDI and PSI historical data by PIF section description. PDI historical data is available since 1985 and PSI historical data is available since 1980.

4. DOPIFSECT: A listing of section descriptions for selected district used by Pavement Management Section to make PIF updates.

5	D0PIFLATE:	Provides the latest PDI and PSI values for a district. This program will include average Road Profiler rutting and IRI (International Roughness Index m/km) values.

If you do not know how to access the main frame or where the programs listed above are located, contact the people listed below.

District	**Name**
1	Karla Schultz
2	John Mishefske
3	Christy Abing
4	Paul Richmond
5	Robert Self
6	Leslie J. Peters
7	John Tyson
8	Jane Olson

APPENDIX G

GLOSSARY

GLOSSARY

AC:

Asphaltic Concrete Pavement.

Alligator Cracking:

A subdivision of a slab created by a crack or cracks in the pavement. The interconnecting cracks form a series of small polygons that resemble an alligator's hide. Caused by failure of the asphalt concrete surface under repeated traffic loading.

Band Cracking:

A narrow band of cracks, transverse and/or longitudinal, in close proximity and less than one foot from a crack, joint or edge. Applicable to AC pavements only.

Binder:

An asphaltic cement used to hold aggregates together.

Block Cracking:

A subdivision of a slab created by a crack or cracks in the pavement. Divides the surface into roughly rectangular pieces typically one square foot or more in size.

Cardinal Direction:

North or East.

Counter(Mechanical):

Device used to count and record number of distress occurrences within a given survey section. .

Crack:

A full depth separation in the PCC which has to be at least 6 feet long to be considered. Hairline cracks are not considered cracks.

Crack Filling:

Temporary patching in a crack to fill any spaces left by distress.

Crazing:

Map cracking or crazing refers to a network of shallow, fine or hairline cracks which extend only through the upper surface of the concrete(applicable to PCC).

CRCP:

Continuously Reinforced Concrete Pavement

Distress:

Visible signs or forms of pavement deterioration which are identified, evaluated, and recorded by, severity and extent. Specific distress definitions and criteria are applicable to the two major distress indicators.

Distressed Joint or Crack:

Deterioration of the concrete within 2 feet of a joint or crack.

Edge Raveling:

The breakup of the edge of the pavement caused by lack of vertical or lateral support, an unstable mix or the effects of traffic. Raveling must occur no more than one foot from the outer edge.

Extent:

This is the level of occurrence of a distress indicator in a survey segment; expressed as sum of the number of occurrence, percent of surface area, or length of segment affected.

Faulting:

Differing elevation between opposing sides of abutting slabs at joints or cracks.

Feature Name:

The name of the section feature at the beginning of the reference point.

Flushing:

Free film of asphalt on the surface of the pavement, creating a greasy, smooth, reflective surface.

Fragment:

Fragmented Slabs

FromRP:

From Reference Point is the reference point at the beginning of a highway section in the cardinal direction.

GT:

Greater than

Hairline Crack:

A fracture which is very narrow.

Inventory Data Forms:

The forms used to record the results of the survey.

Joint:

Contraction joint sawed across the pavement which allows expansion and contraction of PCC pavement.

Joint Spacing:

The average distance between joints, in feet.

Longitudinal:

Parallel to the centerline of the pavement or laydown direction.

Longitudinal Crack:

A crack running approximately parallel to the centerline. Must be at least 6 feet long.

Longitudinal Distortion:

A distress category which incorporates all those pavement distresses resulting in, or the result of, a change in the intended longitudinal profile of the pavement. They include shoving, waves, settlement, heaving or tenting.

Longitudinal Joint Distress:

Distress, such as faulting and general deterioration, of the longitudinal lane joint.

LT:

Less Than

Panel:

Same as Slab.

Patch:

An area where pavement has been removed and replaced with new material. Patches can be either AC or PCC. They can be full or partial depth, as well as full or partial lane. Included are areas where that surface has been machine worked, such as heated then bladed, ground, rotomilled, etc. Wedging, edge or otherwise, is also considered a type of patching.

PCC:

Portland Cement Concrete Pavement.

PDI:

Pavement Distress Index

PDI Manual:

This manual.

Performance:
A measure of accumulated service provided by a facility; i.e., the degree to which a pavement fulfills its purpose.

Popout:
The breaking away of small portions of a concrete surface due to internal pressure which leaves a shallow, typical conical, depression.

PSI:
Pavement Serviceability Index is a numerical estimate of serviceability based on pavement roughness.

Random Skewed Joint:
A contraction joint in PCC pavement which is at an angle other than 90 degrees from the center line, usually at a slope of 1:6 from a line 90 degrees with the centerline.

Raveling:
The wearing away of the pavement surface caused by the dislodging of aggregate particles.

R.P.:
Reference Point, usually corresponds with a landmark along a highway.

Rutting:
The occurrence of longitudinal surface depressions in the wheel-paths.

Scaling:
Local flaking or peeling away of the near surface portion of concrete.

Seal Coat:
Emulsified Asphalt sprayed on pavement with aggregate chips applied.

Segregation:
An open appearance in the asphaltic surface which looks a lot like surface raveling. Often has crescent shape which follows the pattern of the asphalt laying process.

Serviceability:
The ability of a specific section of pavement to serve in its existing condition

Severity:
The level of distress condition determined by estimating the width, length and other specific criteria of a distress indicator. The method of rating severity depends on the distress indicator under consideration.

Slab:

A section of pavement bounded on the ends by joints and bounded on the sides by the center line joint and/or the edge of the pavement, designed for continuity of tensile stresses.

Slab Breakup:

Fracturing of a slab as a result of crack development.

Spall: A fragment, usually in the shape of a flake, detached from a lager mass by a blow, by the action of weather, by pressure, or by expansion within the large mass.

Spalling:

Chipping of the slab surface within 2 feet of a joint or crack.

Station:

A 100 foot distance measured along the edge or centerline of a pavement.

Surface Distress:

Cracking, spalling, scaling, breaking, chipping, raveling, or disintegration of the concrete wearing surface within the slab.

Surface Raveling:

The progressive downward disintegration of the surface by the dislodgement of aggregate particles. Also, it can mean the gradual disintegration of the pavement wearing surface, increasing the texture and coarse aggregate exposure.

Transverse:

Perpendicular to the pavement centerline or direction of laydown.

Transverse Crack:

A crack running approximately at right angles to the centerline. Must be at least 6 feet long.

Transverse Distortion:

A distress indicator which incorporates all pavement distress resulting in, or the result of, a change in the intended transverse profile, or cross section, of the pavement. They include Edge Tipping and Edge Roll-down.

APPENDIX H

NAME LIST

WisDOT STAFF INVOLVED IN PAVEMENT DISTRESS SURVEY PROGRAM

Revised 1/22/1993

DISTRICT	NAME	SECTION	PHONE
C.O.	Peter Amakobe	Pavement Management	(608)246-5308
C.O.	Nancy Busche	Applied Research	(608)246-7957
C.O.	Bill Duckert	Pavement Management	(608)246-5440
C.O.	John Hamm	Applied Research	(608)246-7951
C.O.	Dwight Johnson	Pavement Management	(608)246-7956
C.O.	Mike Malaney	Pavement Management	(608)246-7956
C.O.	Kevin McMullen	Pavement Management	(608)246-5395
C.O.	Roger Peck	Applied Research	(608)246-7957
C.O.	Wayne Ristau	Applied Research	(608)246-7957
C.O.	Scot Schwandt	Pavement Management	(608)246-5396
C.O.	Ray Sorenson	Applied Research	(608)246-5394
1	Mike Adler	Construction	(608)246-5329
1	Bill Carpenter	Planning	(608)246-3865
1	Chuck Grant	Const. & Plan.	(608)246-5356
1	Ed Loos	Planning	(608)246-3862
1	Tim McCarthy	Materials	(608)246-3857
1	John Noll	Planning	(608)246-5356
1	Chuck Orville	Materials	(608)246-3857
1	Rick Pfanku	Const. & Plan.	(608)246-5356
1	Paul Savage	Planning	(608)246-5356
1	Tony Spychalski	Planning	(608)246-5354
2	Michael Bub	Planning	(414)521-5458
2	Len Hedtcke	Planning	(414)548-6761
2	Joe Rocki	Planning	(414)548-6761
2	Arlo Tesmer	Planning	(414)521-5453
3	Dave Andre	Planning	(414)492-5681
3	Richard Conradt	Maintenance	(414)492-5699
3	Kathy Drews	Planning	(414)492-5620
3	Jim Geurts	Maintenance	(414)492-5701
3	Bill Prue	Planning	(414)492-5680
3	Larry Wacker	Planning	(414)492-5678

WisDOT STAFF INVOLVED IN PAVEMENT DISTRESS SURVEY PROGRAM
Revised 1/22/1993

DISTRICT	NAME	SECTION	PHONE
4	Larry Frank	Planning	(715)421-8341
4	Linda Richardson	Materials	(715)421-8056
4	Don Saeger	Planning	(715)421-8348
4	Darwin Sering	Planning	(715)421-8344
4	Greg Stelmacher	Planning	(715)421-8346
5	Mike Lenz	Planning	(603)785-9967
5	Wendy Maedke	Planning	(608)785-9073
5	Judy Shelato	Planning	(608)785-9045
5	Rick Small	Planning	(608)785-9966
5	Mike Vondrashek	Planning	(608)785-9071
6	George Barry	Maintenance	(715)836-3003
6	Gary Flick	Construction	(715)836-2069
6	Gerald Kneer	Maintenance	(715)836-3003
6	Michael Lenroot	Maintenance	(715)836-3004
7	Joe Dreifuerst	Maintenance	(715)369-5755
7	Dave Kircher	Materials	(715)369-5734
7	Frank Loretti	Planning	(715)369-5744
8	Duane Anderson	Materials	(715)392-7996
8	Don Johnson	Des. & Const.	(715)392-7998
8	Jim Larson	Materials	(715)392-7953
8	Tom Sislo	Materials	(715)392-7880

APPENDIX I

COUNTIES AND THEIR DISTRICTS

COUNTIES AND THEIR DISTRICTS

1.	ADAMS	-4-
2.	ASHLAND	-8-
3.	BARRON	-8-
4.	BAYFIELD	-8-
5.	BROWN	-3-
6.	BUFFALO	-5-
7.	BURNETT	-8-
8.	CALUMET	-3-
9.	CHIPPEWA	-6-
10.	CLARK	-6-
11.	COLUMBIA	-1-
12.	CRAWFORD	-5-
13.	DANE	-1-
14.	DODGE	-1-
15.	DOOR	-3-
16.	DOUGLAS	-8-
17.	DUNN	-6-
18.	EAU CLAIRE	-6-
19.	FLORENCE	-7-
20.	FOND DU LAC	-2-
21.	FOREST	-7-
22.	GRANT	-1-
23.	GREEN	-1-
24.	GREEN LAKE	-4-
25.	IOWA	-1-
26.	IRON	-7-
27.	JACKSON	-5-
28.	JEFFERSON	-1-
29.	JUNEAU	-4-
30.	KENOSHA	-2-
31.	KEWAUNEE	-3-
32.	LaCROSSE	-5-
33.	LaFAYETTE	-1-
34.	LANGLADE	-7-
35.	LINCOLN	-7-
36.	MANITOWOC	-3-
37.	MARATHON	-4-
38.	MARINETTE	-3-
39.	MARQUETTE	-4-
40.	MENOMINEE	-3-
41.	MILWAUKEE	-2-
42.	MONROE	-5-
43.	OCONTO	-3-
44.	ONEIDA	-7-
45.	OUTAGAMIE	-3-
46.	OZAUKEE	-2-
47.	PEPIN	-6-
48.	PIERCE	-6-
49.	POLK	-8-
50.	PORTAGE	-4-
51.	PRICE	-7-
52.	RACINE	-2-
53.	RICHLAND	-5-
54.	ROCK	-1-
55.	RUSK	-8-
56.	ST. CROIX	-6-
57.	SAUK	-1-
58.	SAWYER	-8-
59.	SHAWANO	-3-
60.	SHEBOYGAN	-3-
61.	TAYLOR	-6-
62.	TREMPEALEAU	-5-
63.	VERNON	-5-
64.	VILAS	-7-
65.	WALWORTH	-2-
66.	WASHBURN	-8-
67.	WASHINGTON	-2-
68.	WAUKESHA	-2-
69.	WAUPACA	-4-
70.	WAUSHARA	-4-
71.	WINNEBAGO	-3-
72.	WOOD	-4-