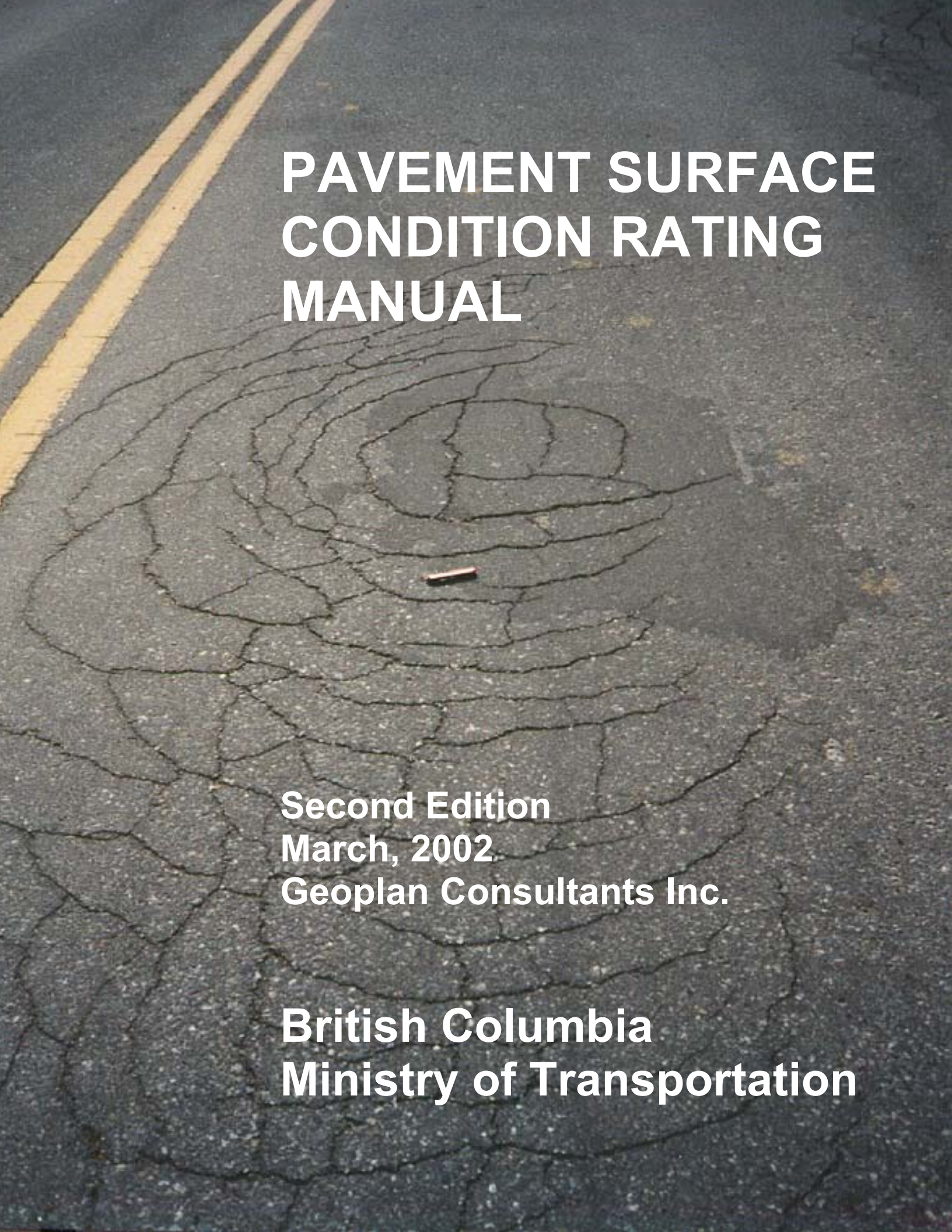

PAVEMENT SURFACE CONDITION RATING MANUAL

Second Edition
March, 2002
Geoplan Consultants Inc.

British Columbia
Ministry of Transportation

Pavement Surface Condition Rating Manual

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Prepared For:

British Columbia
Ministry of Transportation

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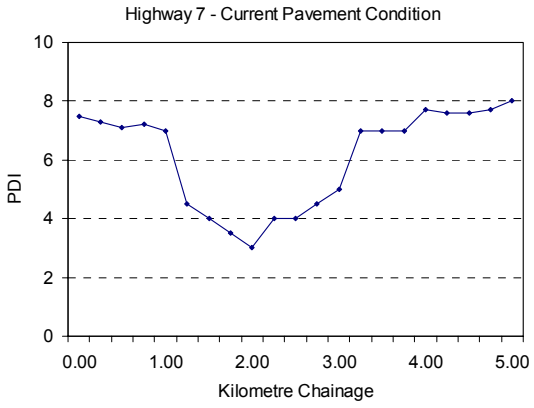
1.0 Introduction

Pavement surface distress is a key performance measure used in asset management systems for monitoring the current condition of a pavement network and predicting future condition.

It is also one of the primary pavement indicators for network level pavement rehabilitation programming and can be used as a diagnostic tool at the project level to gain insight as to the possible cause of pavement deterioration.



Example Use of Distress Data

The British Columbia Ministry of Transportation's *Pavement Surface Condition Rating Manual* was originally released in 1994. The rating methodology was been designed to be applicable for both automated and manual surveys, providing the necessary information for network and project level analysis.

The manual was developed on a review of Ministry pavement distress survey practices at the time and an evaluation of the Transportation Association of Canada and Strategic Highway Research Program distress survey methods.

Since its release in 1994, there have been changes made to the survey procedures based on experience working with the rating system, data collected to date, quality assurance and advancements in surveying technology.

This second release of the Pavement Surface Condition Rating Manual provides an update of current practices and the application of the rating system to meet Ministry asset management needs.

1.1 Features of the System

The purpose of this manual is to provide an accurate and consistent rating methodology with the objective to provide uniform measurements over time for all pavements in the province.

The rating methodology has been designed to be suitable for both automated contract surface distress surveys that are conducted for the Ministry's Roadway Pavement Management System (RPMS) and manual project level surveys.

The rating system includes 12 distress types within the following subgroups:

- Cracking – wheel path, joint, edge, transverse, meandering and alligator.
- Surface Deformation – rutting, shoving and distortion.
- Surface Defects - bleeding, potholes and ravelling.

The distress types selected for the rating system represent the most predominant distress manifestations observed in British Columbia, focusing on those that progressively affect the pavement's ability to support traffic loads.

Each distress type is classified and rated according to its severity and density. In most cases, there are three levels of severity that describes the condition of the distress with definitions for each level – low, moderate and high. There are five ranges of density that indicates the portion of the road surface affected by a specific distress type.

Photographs and drawings of distress types are provided as a reference for assessing severity and general mechanisms of failure listed. Practical rating guidelines for both manual and automated surveying are included along with an overview on the survey procedures, pavement surface condition model and quality assurance specifications for automated surveys. Rating forms are also provided.

2.0 Common Terms

This section provides a glossary of the commonly used terms used throughout the rating manual.

Alligator Cracking - cracks which form a network of multi-sided blocks resembling the skin of an alligator. Block size can range in size which indicates the depth of failure taking place. The pattern of cracking is usually longitudinal, originating in the wheel paths, but can occur transversely due to frost heaves or settlement and also along the centre line on narrow two lane roads.

Bleeding – excess bituminous binder on the pavement surface can create a shiny, glass-like, reflective surface that may be tacky to the touch. Bleeding quite often occurs in the wheel paths.

Density – portion of the road surface affected by a specific distress type. Units can be length, area or number.

Distress – specific type of pavement defect – see Section 5 for definitions.

Distortion - any deviation of the pavement surface from its original shape other than that described for shoving and rutting. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes and to frost heaving, and from residual effects of frost heaving accumulating after each season.

International Roughness Index – a value calculated based on the true profile of the road to represent the roughness qualities that impact vehicle response via its suspension system. The vehicle suspension motion is accumulated and divided by the distance traveled to provide an index, which is reported in units of m/km. An IRI of 0 m/km indicates absolute smoothness with pavement roughness developing at greater than 2.0

Longitudinal Wheel Path Cracking - cracks which follow a course predominantly parallel to the pavement centre line and located at or near the centre of the wheel path.

Longitudinal Joint Cracking - cracks which occur along or in the immediate adjacent vicinity of the longitudinal centre line pavement joint.

Meandering Longitudinal Cracking - cracks which wander from edge to edge of the pavement or run parallel to the centre line, situated near the middle of the lane. Meandering longitudinal cracks are usually single cracks, but secondary cracks can develop.

Network Level – an assessment of all road sections within an entire network (i.e. province) to identify pavements that are deficient, according to standard performance measures. In terms of condition rating, it involves a more general inventory of deficiencies and flagging of problem areas.

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

Project Level – detailed evaluations of specific roadway sections identified as candidates for rehabilitation. In terms of condition rating, the purpose is to evaluate the deterioration in sufficient detail to determine possible rehabilitation treatments.

Pavement Condition Rating – a composite rating that combines the pavement distress and riding comfort indices on an equal basis into a single value, from 10 to 0 (good to poor) for corporate reporting.

Pavement Distress Index – a value from 10 to 0 (good to poor) calculated based on the combination of surface distresses, severity and density ratings that exist for a road segment using the Paver model that has been modified for B.C. conditions.

Pavement Edge Cracking - cracks which occur parallel to and within 0.6 metres of the inside and outside of the fog line. Cracks may be crescent shaped cracks or other fairly consistent cracks which intersect the pavement edge

Ravelling - the progressive loss of the pavement material (both aggregate particles and bituminous binder) from the surface downward, leaving a rough surface, vulnerable to weather deterioration.

Roadway Pavement Management System (RPMS) - a corporate application that supports the planning, programming and delivery of the Ministry's annual resurfacing plan. The system is used for monitoring the condition of the paved highways, determining and justifying provincial resurfacing funding priorities and

developing regional rehabilitation programs. It also supports pavement design work and planning studies, including the provincial highway plan and its related corridor projects.

Riding Comfort Index – a value from 10 to 0 that is calculated for a road segment using the IRI measurements, where 10 indicates a smooth pavement.

Roughness - a measure of the riding comfort experienced by the road user. The roughness may be due to deficiencies with the original construction or the result of deterioration from traffic and environmental conditions. The extent of the pavement distortion combined with a vehicle's suspension and operating speed all contribute to the ride quality.

Rutting – longitudinal depressions located in the wheel paths of a travel lane following repeated loadings.

Severity - describes the condition of the distress with definitions for each level – low, moderate and high

Shoving - longitudinal displacement of a localized area of the pavement surface, generally caused by braking or accelerating vehicles and usually located on hills, curves or intersections.

Spalling – deterioration of the sharp edges of a pavement crack and if severe, pieces of pavement can break away causing the width of the crack on the surface to be wider than below.

Surface Distress – a measure of the overall, pavement surface deterioration.

Transverse Cracking - cracks that are predominantly perpendicular to the pavement centre line and may extend fully or partially across the roadway

Wheel path – there are two wheel paths per traffic lane with the outside wheel path closest to the shoulder and the inside wheel path closest to the centre line or median.

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3.0 Pavement Condition Surveys

This section provides an overview of automated contract surveys and manual project level pavement distress surveys.

3.1 Automated Contract Surveys

As part of its asset management practices, the Ministry of Transportation has implemented a multifaceted pavement management program. It is built around the Roadway Pavement Management System (RPMS) and supported by comprehensive data collection procedures.

The Ministry measures pavement performance according to surface distress and pavement roughness. These are the predominant types of performance data collected by highway agencies for network condition monitoring.

The objective of the RPMS surveys is to obtain performance data that is sufficiently accurate, representative and consistent for network level analyses. This dictates the rating methodology and measuring equipment that are used for the surveys.

The surveys are conducted by contractors using automated road testing vehicles equipped with sophisticated on-board systems and instrumentation. The use of a third party contractor to collect the data provides objectivity and consistency throughout the province. The surveys and data post processing are guided by quality assurance procedures to ensure the data is collected accurately and repeatable from year to year.

A brief description of the types of data collected and the equipment used for the RPMS automated surveys follows.

Surface Distress

Ten distress types based on three levels of severity and five levels of density are rated on a continuous basis using windshield surveys with integrated boards. The rating is performed in accordance with the BCMoT Pavement Surface Condition Rating Manual. The rating data is reported continuously at 50 metre intervals.

The distress types included for these network level surveys are: (1) longitudinal wheel path cracking, (2) longitudinal joint cracking, (3) pavement edge cracking, (4) transverse cracking, (5) meandering longitudinal cracking, (6) alligator cracking, (7) potholes, (8) rutting, (9) distortion and (10) bleeding. Please note that ravelling and shoving are not collected as part of the RPMS surveys.

Rutting

The transverse profile of the travel lane is measured on a continuous basis using 10 environmental grade ultrasonic transducers, mounted on a specially designed front vehicle bumper with extension wings. The sensor measurements are recorded across the full lane profile and used to calculate the average rut depths for each wheel path at 50-metre intervals.

Roughness

Longitudinal profile roughness measurements are collected for each wheel path on a continuous basis using a laser profiler-accelerometer that conforms to the FHWA Class II Profiler Specification. The data is collected and reported at 50 metre averaged intervals as per the International Roughness Index (IRI) protocols.

Right of Way Video Logs

A continuous high resolution video log captures the full width of the pavement surface and shoulders as well as any roadside features such as signs, structures and guard rails. This view is captured as a forward-looking view from the front of the data collection vehicle. The video is used during the survey QA and planning.

The RPMS automated surface condition surveys are conducted every two years on the primary highway system, every three years for secondary highways and on a four year cycle for paved side roads.

3.2 Project Level Manual Surveys

Manual surface distress surveys are routinely conducted during the detailed evaluations that are carried out for candidate rehabilitation projects. In addition to distress surveys, this can include geotechnical investigations, strength testing, coring and laboratory testing.

The purpose of the project level manual distress surveys is to provide a more accurate and detailed investigation of the pavement deterioration in order to assist in determining appropriate rehabilitation treatments.

The manual surface distress mapping method consists of an individual walking the pavement section and recording, with the aid of a tape measure, measurements of all existing distress features and plotting them on a map. The project limits are generally divided into 20 metre segments for rating purposes.

Based on the crack mapping and visual observation, the individual assigns the severity and density ratings for the distress types identified using the rating manual guidelines and photographs as references.

Rutting is rated based upon the measured wheel path rut depths. Both the right and left wheel path rut depths are measured using a two metre straight edge or the BC Smoothness Gauge.

4.0 Inspection Guidelines

This section of the manual provides practical guidelines for identifying distresses, rating severity/density and conducting manual surveys. It also outlines considerations for automated surveys and lane numbering.

4.1 Distress Identification

- Distress ratings apply only to the travel lane portion with the exception of pavement edge and longitudinal joint cracks.
- Longitudinal joint cracks can occur +/- 300 mm on either side of the centre line.
- If there is doubt between whether it is longitudinal joint crack or a longitudinal wheel path crack, assign the latter.
- Pavement edge cracks must be within 600 mm of the fog line.
- Alligator cracking is a load related distress that is indicative of structural failure in the layer materials and will generally be either longitudinally or defined as isolated blowouts.
- Alligator cracking is to be double counted, where it exists as part of another distress type.

  For example, alligator cracking in a wheel path would be recorded as severe wheel track cracking and alligator cracking

- Potholes are to be double counted where they occur as part of another distress type. For example, a pothole in a transverse crack would be recorded as a severe transverse crack and a pothole.

4.2 Rating Severity

- When rating crack widths, use the average width and not the extremes as the intent is to rate the overall severity of the crack.
- *10 Percent Rule* - the assigned severity level is the highest severity level present for at least 10 percent of the extent of the distress type within the rating segment. If at least 10% of the crack is in a higher severity level, the higher level is assigned. For example, a transverse crack is two metres in length, with 25 cm at high severity and the remainder at moderate, the crack is assigned a high severity level.

Example of 10% Rule

- Cracks which are not fully sealed, with the underlying crack width clearly visible, are rated according to the normal severity definitions.
- Low severity cracks can only consist of single cracks and no spalling.
- Moderate severity cracks can consist of single or multiple cracks with moderate spalling.
- High severity cracks can consist of single or multiple cracks with severe spalling.
- There are only moderate and high severity levels for alligator cracking, distortion, ravelling and bleeding.
- Cracks that are fully sealed are rated as low severity.
- Rutting is categorized into three severity levels based on an average rut depth range and this applies to both manual and automated rating methods.

4.3 Rating Density

- The units of measurement for density are listed below for each distress type.

Distress Type	Units
Longitudinal Wheel Path Cracking	Length (m)
Longitudinal Joint Cracking	Length (m)
Pavement Edge Cracking	Length (m)
Transverse Cracking	Number
Meandering Longitudinal Cracking	Length (m)
Alligator Cracking	Area (m^2)
Rutting	Length (m)
Shoving	Length (m)
Distortion	Length (m)
Bleeding	Length (m)
Potholes	Number
Ravelling	Length (m)

- Number means the number of transverse cracks or potholes identified within.
- Length means the proportionate length of the distress identified within the rating segment.
- Quantification of distress density is based on evaluation of the single lane rating segment (50 m for automated surveys and 20 m for manual).
- The density calculations for longitudinal wheel path cracking, rutting, shoving and bleeding provides for measurement of the surface distress in each wheel path. It is based on a total length of two times the segment length (i.e. 20 metre segment: 2 x 20 = 40 metre total wheel path length).
- For automated surveys, transverse cracking and potholes only have 3 levels of density due to the units of measurements and rating methodology.

4.4 Manual Survey Rating Guidelines

- Rating segments are 20 metres in length and one lane width for manual project level surveys
- The rating individual is advised to mark out the test segments in advance using a tape measure to assist in the distress mapping. Forms to be used for the distress mapping are provided in this manual.
- All provincial regulations and traffic control requirements must be followed.
- Each test segment should be evaluated separately, with the distress types and severity/extent ratings assigned while on the site.
- For distress mapping purposes, abbreviations for the distress types are used with the severity level identified on the map. For example, TC-M denotes a transverse crack of moderate severity. Cracks that have been fully sealed are denoted with a subscript "s" (i.e. TC_s).
- Any features that cannot be drawn on the distress mapping form should be noted in the comments section.
- Both the left and right wheel path rut depths should be measured at 5 metre intervals. The highest rut depth measurement identified within the test segment is used as the criteria for assigning the severity.
- Following the manual rating of all the test segments, the individual should walk the entire site a few times to ensure that the severity and density ratings have been consistently applied.
- The relative angle of the sun and the roadway surface viewing direction can have a significant impact on visual observations. When conducting manual surveys, make sure to view the pavement from more than one direction.

4.5 Automatic Survey Considerations

- Rating segments are 50 metres in length and one lane width for automated contract surveys.
- In general terms, the automatic distress surveys are performed solely according to the distress rating definitions.
- The calculated rut depths and roughness measurements are based on the averaged readings over the preceding 50 metre segment.
- The following hours of operation shall apply for the automated surveys:
    - Surveys are to be conducted between sunrise and sunset;
    - From sunrise until 12:00 noon, surveys shall only be conducted in northerly and easterly directions; and
    - From 12:00 noon to sunset, surveys shall only be conducted in southerly and westerly directions.
- The severity rating for rut depths is based on the averaged left and right wheel path rut depth measurements as follows:

None -	<3 mm is the practical level of accuracy for automated rut depth measuring systems
Low -	average rut depth ≥ 3 mm and ≤ 10 mm
Moderate -	average rut depth > 10mm and ≤ 20 mm
High -	average rut depth >20 mm

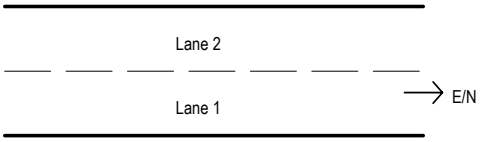
- The density rating is assigned based on the existence of rutting in either wheel path according to the 3 mm accepted accuracy level.

0% -	if neither of the wheel path rut depths are ≥ 3 mm
90% -	if both wheel path rut depths are ≥ 3 mm
35% -	if only one of the wheel path rut depths is ≥ 3 mm

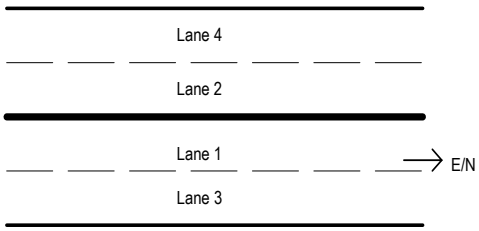
The values above refer to the midpoints of the distress density rating system that specifies throughout as 80 to 100% and intermittent as 20 to 50%.

4.6 Lane Numbering Convention

- On two lane roads, the lane to the right of the centre line when moving in the northbound or eastbound direction is lane 1 and lane 2 for the opposing direction.



- On multi-lane roads, the median is used as the centre line. When moving in the northbound or eastbound direction, the lanes to the right of the median are numbers 1, 3, 5, etc. and the lanes to the left of the median are numbers 2, 4, 6, etc.



5.0 Flexible Pavement Distresses

The pavement surface condition rating system includes 12 distress types within the following major subgroups:

Cracking

- Longitudinal Wheel Path Cracking (LWP)
- Longitudinal Joint Cracking (LJC)
- Pavement Edge Cracking (PEC)
- Transverse Cracking (TC)
- Meandering Longitudinal Cracking (MLC)
- Alligator Cracking (AC)

Surface Deformation

- Rutting (RUT)
- Shoving (SHV)
- Distortion (DST)

Surface Defects

- Bleeding (BLD)
- Potholes (POT)
- Ravelling (RAV)

Please note that shoving and ravelling are not included in the automated RPMS pavement surface conditions distress surveys. Shoving seldom occurs on rural highways and is more project specific. It is also not possible to accurately rate ravelling on asphalt surfaces during the automated surveys due to travel speed, lighting conditions and level of subjectivity involved.

5.1 Longitudinal Wheel Path Cracking (LWP)

Description: Cracks which follow a course predominantly parallel to the pavement centre line and located at or near the centre of the wheel path.

Possible Causes: Heavy traffic during spring thaw when pavements are weak.

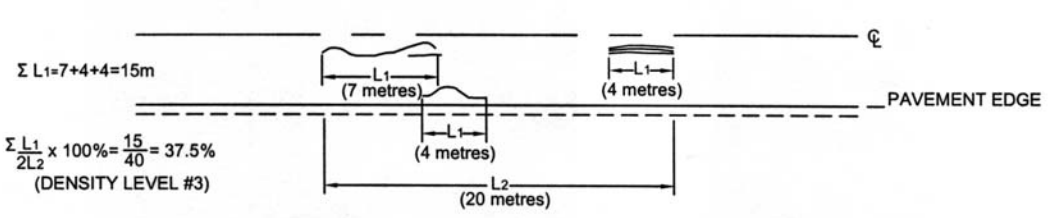
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Example:



Longitudinal Wheel Path Cracking (LWP)

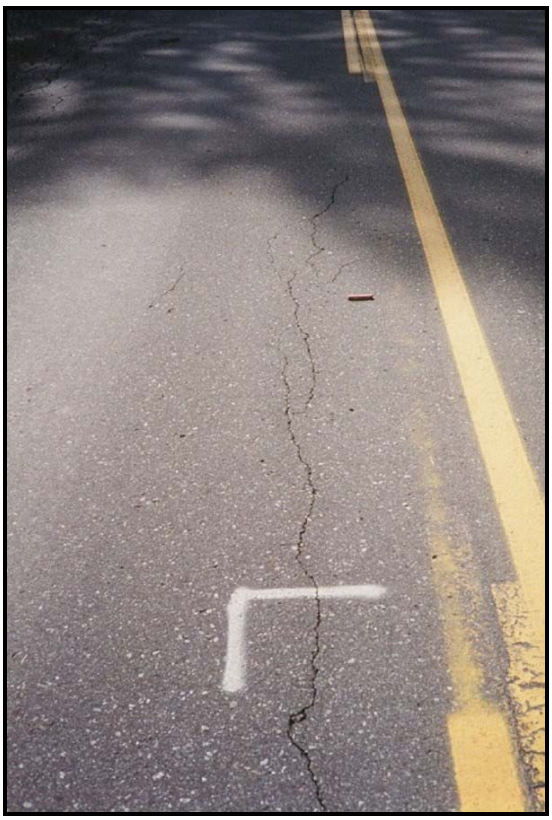
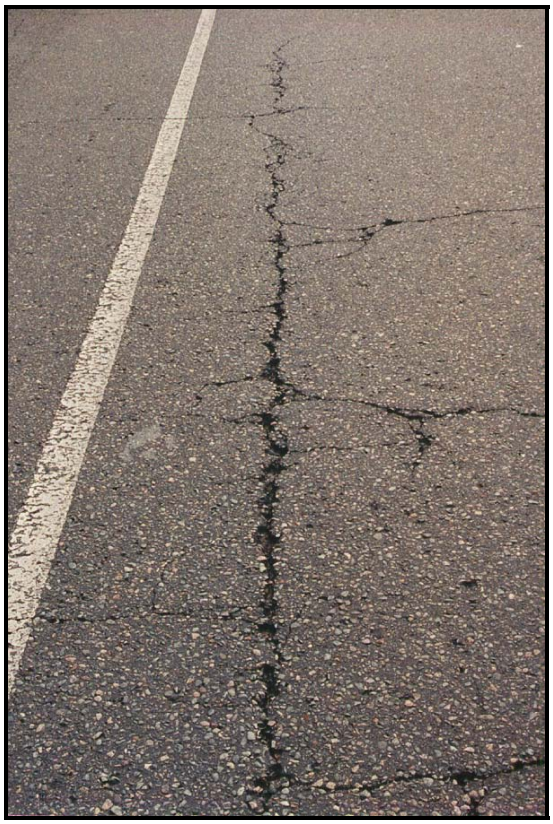


Figure 1 - Low Severity LWP

Figure 2 - Moderate Severity LWP



Longitudinal Wheel Path Cracking (LWP)

Figure 3 - High Severity LWP (multiple cracks)

Figure 4 - High Severity LWP (alligator cracking)

5.2 Longitudinal Joint Cracking (LJC)

Description: Cracks which occur along or in the immediate adjacent vicinity of the longitudinal centre line pavement joint.

Possible Causes:

- Poor construction of longitudinal joint.
- Frost action on adjacent lanes with variable granular depths. Differential frost heave along the centre line caused by the insulating value of snow along pavement edges.
- Moisture changes resulting in swelling and shrinkage

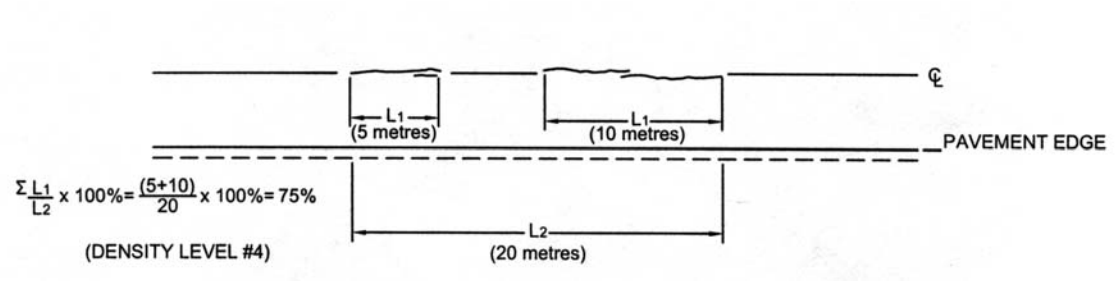
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

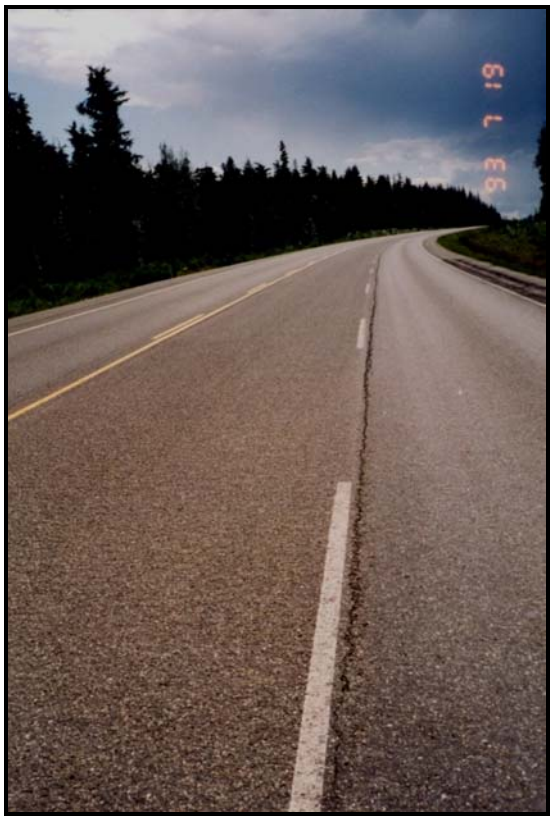
Example:



Longitudinal Joint Cracking (LJC)

Figure 5 - Low Severity LJC

Figure 6 - Moderate Severity LJC



Longitudinal Joint Cracking (LJC)

Figure 7 - High Severity LJC (multiple cracks)

Figure 8 - High Severity LJC (single crack)

5.3 Pavement Edge Cracking (PEC)

Description: Cracks which occur parallel to and within 0.6 metres of the inside and outside of the fog line. Cracks may be crescent shaped cracks or other fairly consistent cracks which intersect the pavement edge.

Possible Causes:

- Frost action.
- Inadequate pavement structural support at the pavement edge and/or excessive traffic loading.
- Poor drainage at the pavement edge and shoulder.
- Inadequate pavement width forces traffic too close to the pavement edge.

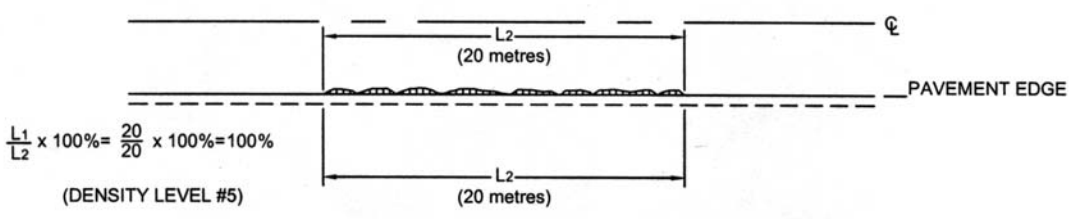
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Pavement Edge Cracking (PEC)

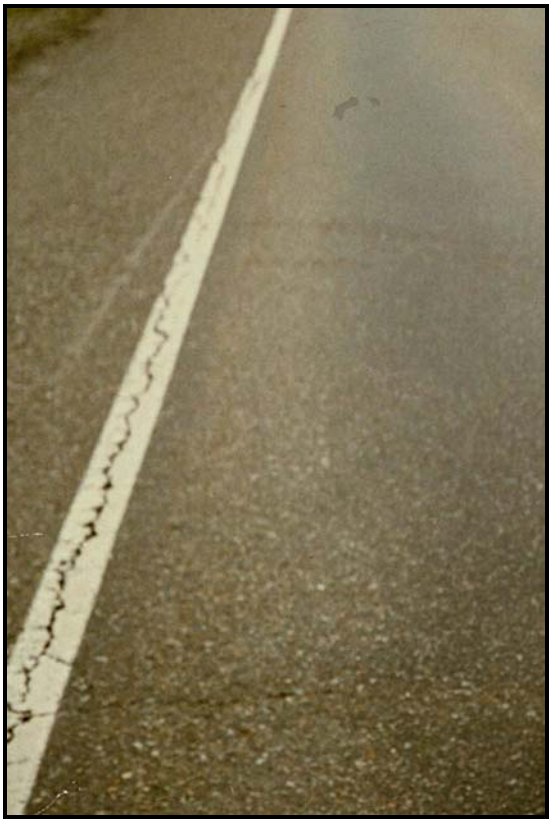


Figure 9 - Low Severity PEC

Figure 10 - Moderate Severity PEC

Pavement Edge Cracking (PEC)

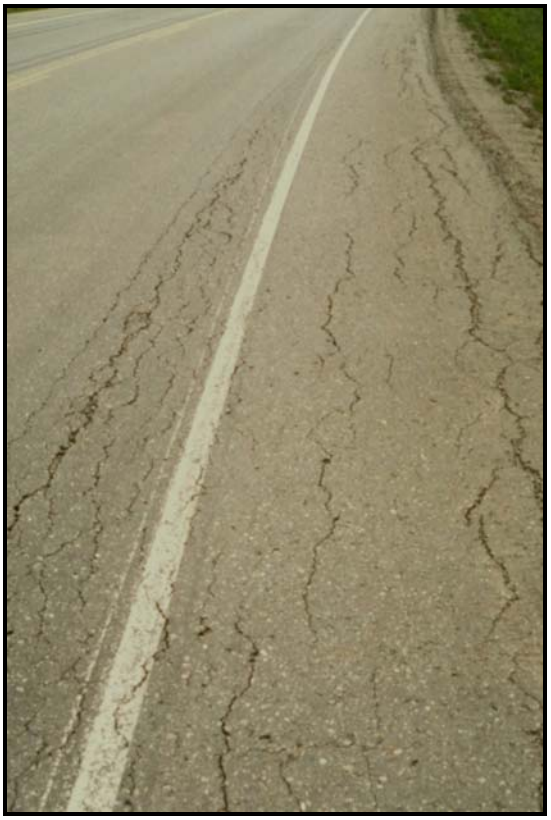


Figure 11 - High Severity PEC (paved shoulder)

Figure 12 - High Severity PEC

5.4 Transverse Cracking (TC)

Description: Cracks that are predominantly perpendicular to the pavement centre line and may extend fully or partially across the roadway.

Possible Causes:

- Surface shrinkage caused by low temperatures.
- High temperature susceptibility of the asphalt cement binder in asphalt mixes.
- Frost action.
- Reflection cracks.

Severity:

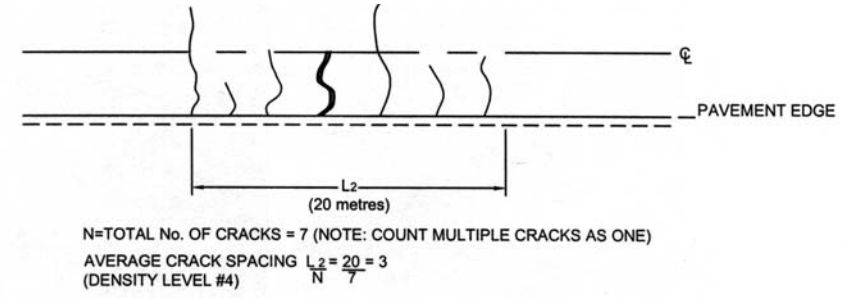
Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Average Crack Spacing
1	Few	10 - 20 m
2	Intermittent	7 - 10 m
3	Frequent	4 - 7 m
4	Extensive	2 - 4 m
5	Throughout	< 2 m

For automated surveys, there are only 3 density levels: Few (10 to 20 m), Frequent (2 to 10 m) and Throughout (<2m).

Example:



Transverse Cracking (TC)

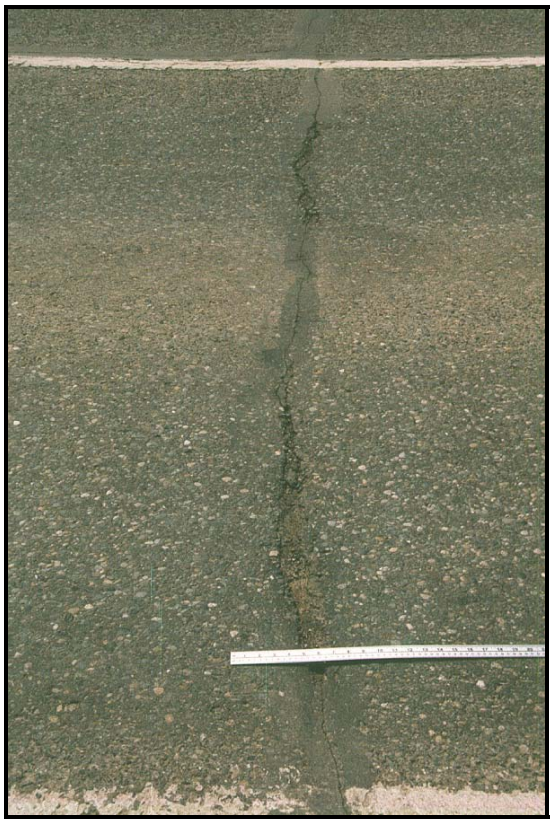
Figure 13 - Low Severity TC

Figure 14 - Moderate Severity TC

Transverse Cracking (TC)

Figure 15 - High Severity TC (multiple cracking and spalling)

Figure 16 - High Severity TC



5.5 Meandering Longitudinal Cracking (MLC)

Description: Cracks which wander from edge to edge of the pavement or run parallel to the centre line, situated near the middle of the lane. Meandering longitudinal cracks are usually single cracks, but secondary cracks can develop in areas where transverse thermal cracks also exist.

Possible Causes:

- Frost action with greater heave at the pavement centre than at the edges. This is more prevalent in mixes where asphalt stripping is extensive.
- Faulty construction equipment can cause weak planes in the mix, which can fail from thermal shrinkage

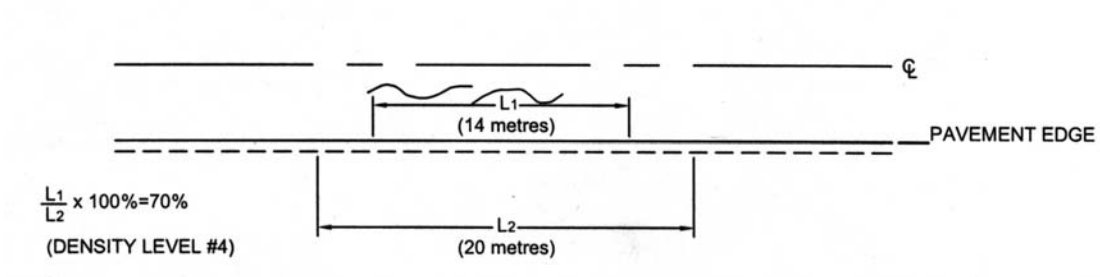
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Meandering Longitudinal Cracking (MLC)

Figure 17- Low Severity MLC

Figure 18 - Moderate Severity MLC
(with secondary transverse cracking)

Meandering Longitudinal Cracking (MLC)

Figure 19 - High Severity MLC
(multiple and alligator cracking)

Figure 20 - High Severity MLC

5.6 Alligator Cracking (AC)

Description: Cracks which form a network of multi-sided blocks resembling the skin of an alligator. Block size can range in size which indicates the depth of failure taking place. The pattern of cracking is usually longitudinal, originating in the wheel paths, but can occur transversely due to frost heaves or settlement and also along the centre line on narrow two lane roads.

Possible Causes:

- Usually areas subjected to repeated traffic loadings.
- Insufficient bearing support due to poor quality base materials or saturated base with poor drainage.
- Stiff or brittle asphalt mixes at cold temperatures.

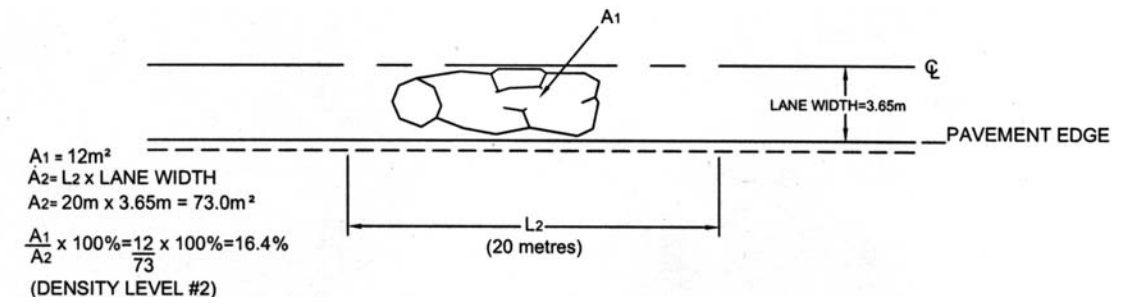
Severity:

Level	Description
Moderate	Interconnected cracks forming a complete block pattern; slight spalling and no pumping
High	Interconnected cracks forming a complete block pattern, moderate to severe spalling, pieces may move and pumping may exist

Density:

Level	Description	Percent Surface Area Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Alligator Cracking (AC)

Figure 21 - Moderate Severity AC
(progressed from multiple cracks)

Figure 22 - Moderate Severity AC (localized failure)

Alligator Cracking (AC)

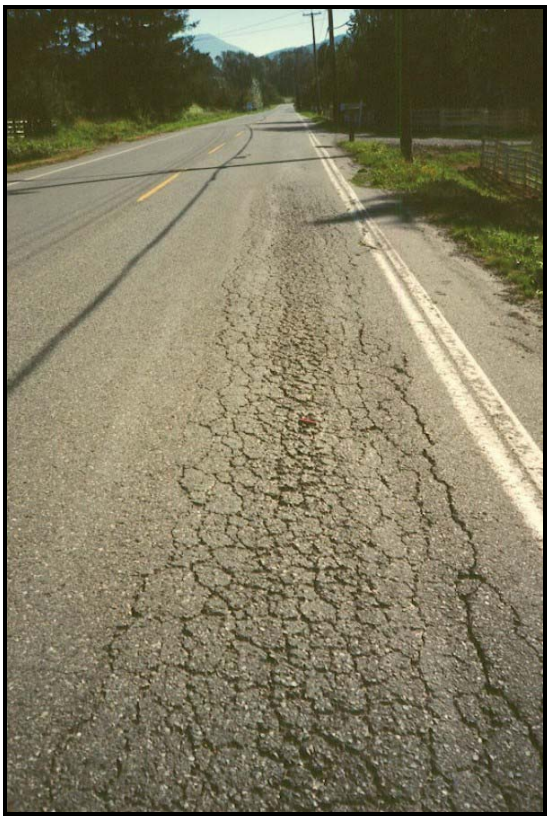


Figure 23 - High Severity AC (spalling and frequent density)

Figure 24 - High Severity AC with break up and pumping

5.7 Rutting (RUT)

Description: Longitudinal depressions left in the wheel paths after repeated loadings, combined with sideways shoving of the pavement material.

Possible Causes:

- Poorly compacted structural layers.
- Heavy loadings of saturated unstable granular bases/subbases during spring thaw periods.
- Unstable asphalt mixes due to high temperature or low binder viscosity.
- Inadequate lateral support from unstable shoulder materials.
- Permanent deformation of an overstressed subgrade.

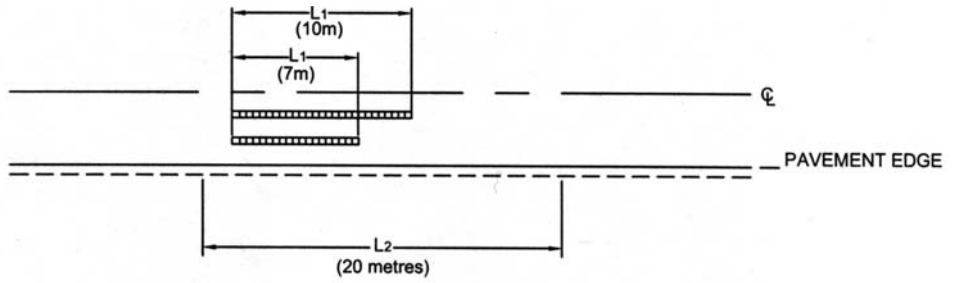
Severity:

Level	Description
Low	Rut depth is less than 10 mm
Moderate	Rut depth is in the range of 10 to 20 mm
High	Rut depth is greater than 20 mm.

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Rutting (RUT)

Figure 25 - Low Severity RUT

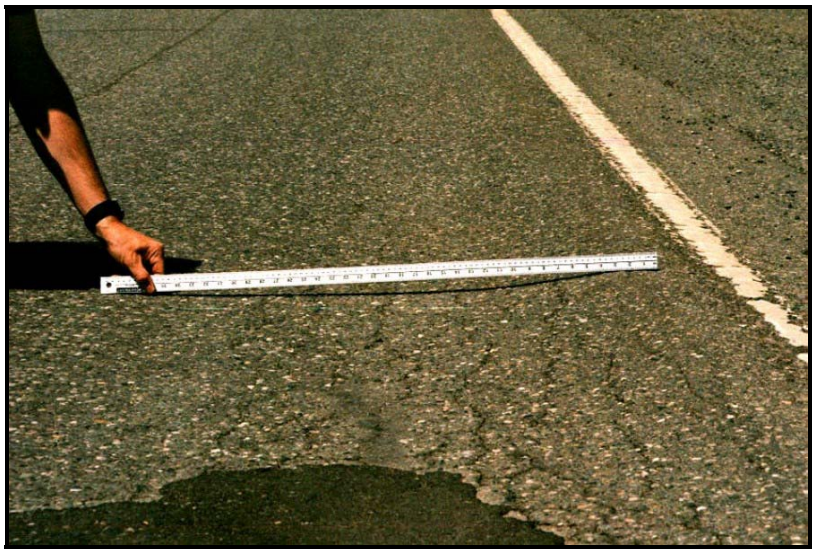


Figure 26 - Moderate Severity RUT

Rutting (RUT)

Figure 27 - High Severity RUT with transverse displacement

Figure 28 - High Severity RUT

5.8 Shoving (SHV)

Description: Longitudinal displacement of a localized area of the pavement surface, generally caused by braking or accelerating vehicles and usually located on hills, curves or intersections.

Possible Causes:

- Stop and start of vehicles at intersections.
- Heavy traffic on steep downgrades or upgrades.
- Low stability asphalt mix.
- Lack of bond in asphalt surface and underlying layer
- Unstable granular base

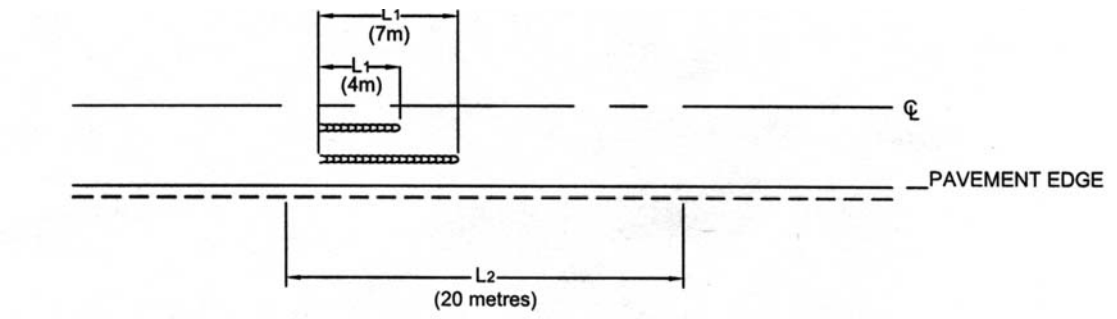
Severity:

Level	Description
Low	Barely noticeable to noticeable
Moderate	Rough ride
High	Very rough ride

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



SURFACE LENGTH AFFECTED = $\frac{\Sigma L_1}{2L_2} \times 100\% = \frac{(4+7)}{(20 \times 2)} \times 100\% = \frac{11}{40} \times 100\% = 27.5\%$

(DENSITY LEVEL #3)

Shoving (SHV)

Figure 29 - Typical case at downgrade intersection with heavy loadings

Figure 30 - High Severity SHV (defined by relative effect on ride quality)

5.9 Distortion (DST)

Description: Any deviation of the pavement surface from its original shape other than that described for shoving and rutting. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes and to frost heaving, and from residual effects of frost heaving accumulating after each season.

Possible Causes:

- Differential frost heave in poorly drained cuts, transitions and at pavement edges or centre.
- Reverse differential frost heave at culverts.
- Differential settlement of subgrade or base materials.
- Lack of subgrade support.
- Embankment slope failure

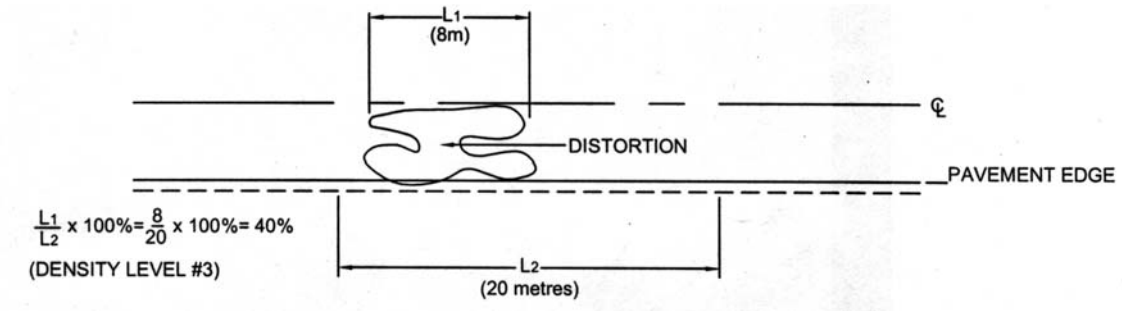
Severity:

Level	Description
Moderate	Noticeable swaying motion; good car control
High	Fair to Poor car control

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Distortion (DST)

Figure 31 - Moderate Severity DST
(resulting from differential settlement)

Figure 32 - Moderate Severity DST
(example of pavement edge settlement)

5.10 Bleeding (BLD)

Description: Excess bituminous binder on the pavement surface can create a shiny, glass-like, reflective surface that may be tacky to the touch. Bleeding quite often occurs in the wheel paths.

Possible Causes:

- Mix design deficiencies where too high an asphalt content relative to voids results in excess asphalt forced to the surface by traffic, especially on hot days.
- Paving over surfaces with severe bleeding or the application of a heavy prime or tack coat under a new pavement layer may result in excess primer bleeding through the pavement surface over a period of time.
- Poor construction of surface seal coats.

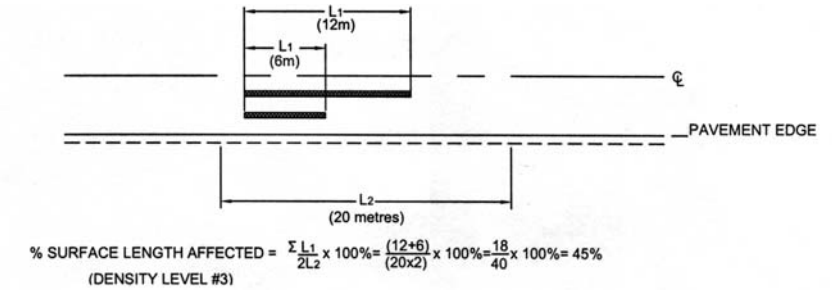
Severity:

Level	Description
Moderate	Distinctive appearance with free excess asphalt
High	Free asphalt gives pavement surface a wet look; tire marks are evident

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Bleeding (BLD)

Figure 33 - Moderate Severity BLD

Figure 34 - High Severity BLD

5.11 Potholes (POT)

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

Possible Causes:

- Thin spot in the asphalt layer.
- Localized drainage problems such as water infiltration through poorly bonded pavement structural layers or segregated spots in the asphalt mix where coarse patches allow intrusion of water
- Asphalt mix design deficiencies.

Severity:

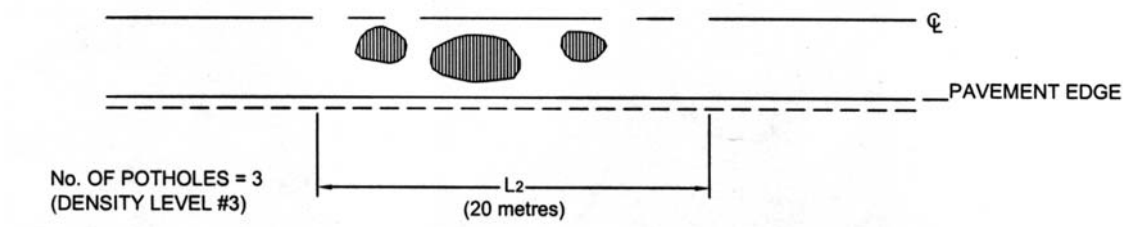
Level	Description
Low	Pothole depth is less than 25mm
Moderate	Pothole depth is 25-50mm
High	Pothole depth is greater than 50mm

Density:

Level	Description	Number of Potholes
1	Few	1
2	Intermittent	2
3	Frequent	3 to 5
4	Extensive	6 to 9
5	Throughout	> 10

For automated surveys, there are only 3 density levels: Few (1-2), Frequent (3-9) and Throughout (>10).

Example:



Potholes (POT)

Figure 35 - Low Severity POT

Figure 36 - Moderate Severity POT (close up view)

Potholes (POT)

Figure 37 - High Severity POT

Figure 38 - High Severity POT (AC with pieces broken out)

5.12 Ravelling (RAV)

Description: The progressive loss of the pavement material (both aggregate particles and bituminous binder) from the surface downward, leaving a rough surface, vulnerable to weather deterioration.

Possible Causes:

- Poor adhesion of aggregates due to insufficient asphalt content, clay-coated aggregate, use of wet aggregates or stripping due to water action.
- Fracture of aggregate particles due to load or natural causes which can be removed by traffic.
- Poor compaction permits infiltration of water and salts which promote asphalt stripping.
- Segregated mix placed during construction.
- Aging and weathering.

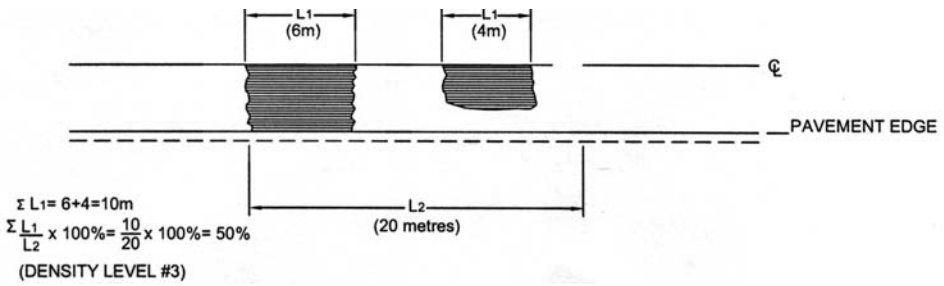
Severity:

Level	Description
Moderate	aggregate and/or binder worn away; surface texture rough and pitted; loose particles exist
High	aggregate and/or binder worn away; surface texture is very rough and pitted

Density:

Level	Description	Percent Length Affected
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



Ravelling (RAV)

Figure 39 - Moderate Severity RAV

Figure 40 - High Severity RAV

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6.0 Miscellaneous Ratings

In addition to the distress types described previously, there are some other related defects that can be rated during pavement surface condition surveys. This includes the following:

- Drainage Conditions;
- Crack Sealing; and
- Patching.

Please note that these additional defects are not included in the automated RPMS pavement surface conditions surveys.

6.1 Drainage Conditions

During the pavement surface condition rating process, observation and general rating of adjacent drainage conditions is performed. This information is for general regional use and may, in some cases, provide an explanation to the occurrence of specific distress types. Local drainage conditions are rated as Acceptable, Borderline or Unacceptable according to the criteria specified below:

ACCEPTABLE
• Cross section and drainage are fully adequate. • Concealed underground storm drains in good repair. • Open ditching with no free-standing water and no silt bottom layer or obstructed culverts, etc. • Open ditching with free-standing water or bull rushes in the ditch and the fill height is greater than 1.5 metres.
BORDERLINE
• If the ditch grade line, cross-section elements and/or culvert and/or ditch capacity are somewhat below the standard that would be provided if the road and ditches were rebuilt. • Roads with acceptable design characteristics, but poorly maintained ditching, requiring work to be brought up to an acceptable level. Work required should generally fall into a category that could be completed by gradual cleaning of ditches, grading of shoulder areas and minor culvert repair.
UNACCEPTABLE
• Free-standing water in ditches, grass and other debris, requiring more than minor work to be brought up to an acceptable standard; granular washout of shoulder areas, etc. • Conditions could impede safe traffic movement. • Areas with lack of grade could possibly flood. • Catch basins are in a very poor state of repair with obvious pavement deterioration and free-standing water. • Water channels onto driven portion of road. • Road drains onto adjacent occupied properties

Drainage Conditions

Figure 41 – Acceptable Drainage

Figure 42 – Unacceptable Drainage

6.2 Crack Sealing

During the pavement surface condition rating process, observation and general rating of crack sealing is performed. This information is for general regional information purposes and may provide further explanation as to the pavement deterioration.

The crack sealing rating is applied based on a combined visual assessment of all crack types within the rating segment.

LEVEL 1
< 30% of cracks are sealed
LEVEL 2
30% to 60% of cracks are sealed
LEVEL 3
> 60% of cracks are sealed

Crack Sealing

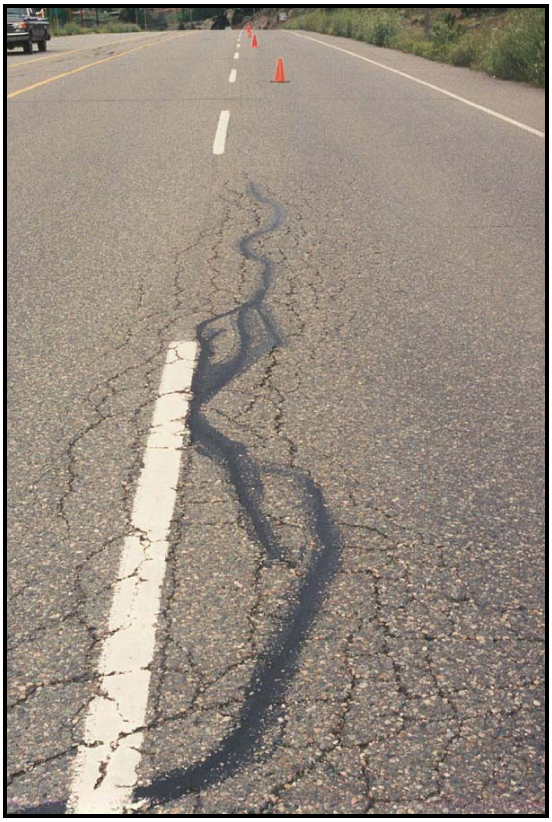

Figure 43 - Level 1 Sealing

Figure 44 - Level 3 Sealing

6.3 Patching

During the pavement surface condition rating process, observation and general rating of patching is performed. This information is for general regional information purposes and may provide further explanation as to the pavement deterioration.

The rating of patching rating is applied based on a visual assessment of patched surface area within the rating segment.

LEVEL 1
Few small localized patches
LEVEL 2
Several larger patches
LEVEL 3
Full lane patching

Patching

Figure 45 - Level 1 Patching

Figure 46 - Level 2 Patching

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7.0 Pavement Surface Distress Index

This manual has described the various types of pavement distress that are collected during the RPMS surveys for measuring pavement surface condition. While this detailed information is very useful at the project level for diagnostic purposes, it is also necessary to aggregate the data into a meaningful composite statistic for network level interpretation.

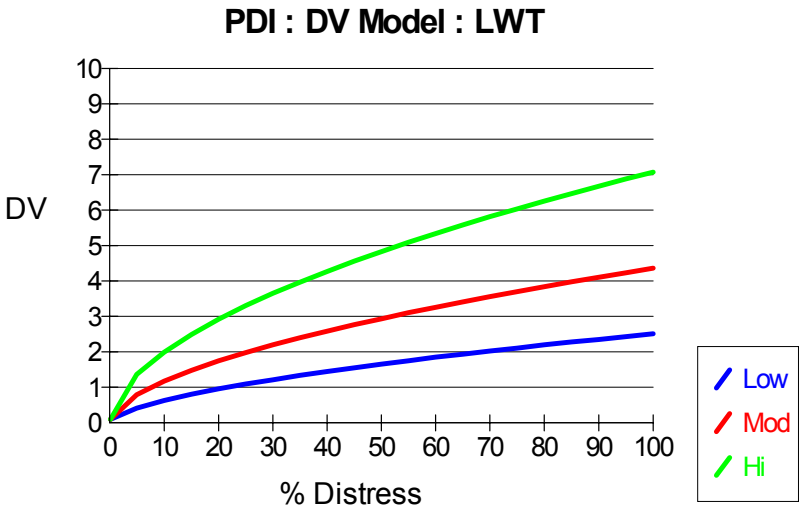
Pavement surface distress is a key corporate performance measure used by the Ministry for asset management. The data provides the basis for monitoring the current and future condition of a pavement network and is a primary indicator for network level rehabilitation programming by providing an objective and consistent comparison of pavements throughout the province. It is also used for regional project planning, pavement design, corporate performance measure reporting, corridor studies and the Provincial Highway Plan

7.1 PDI Model

The detailed survey data is converted into a single composite statistic called the Pavement Distress Index (PDI), using a mathematical model that is integrated within the Ministry's pavement management system. The model is a modified format of the *Paver PCI*, which was developed by the U.S Army Corps of Engineers and has been widely implemented in pavement management systems.

The PDI model incorporates the severity and density ratings for each distress type and converts the data to a single distress score based on a declining condition scale from 10 to 0. This score is determined by calculating "deduct values" for each distress type that is present. Starting at a perfect score of 10, deductions are made for each distress type.

The magnitude of the deduction (DV) is based on the combination of severity and density for each particular distress type. For example a distress type with high severity and density will have a larger deduction than a lower severity and density (see figure below).



Each distress type is also weighted, recognizing the type of deterioration and remedial action required. For example alligator cracking and bleeding are heavily weighed since they represent a structural and safety problem with the pavement. However, pavement edge cracking is not considered as significant, since the deterioration is not located within the travel lane.

Calibration of the PDI model involved several iterations of model refinement, other agencies work, extensive data analyses and incorporating Ministry pavement expertise and knowledge directly into the model. This was followed by extensive ground-truthing and post evaluations to verify the accuracy of the model.

The RPMS has the capability to analyze and refine the surface distress coefficients as required for future modifications.

7.2 Interpretation

The PDI is based on a declining performance scale from 10 to 0. To assist in interpreting the condition data, a generalized classification system was developed. It was based on other agencies work, data analysis, expert opinion and field verification.

As shown below, the classification scheme is comprised of three condition categories. Each category is defined according to the level of pavement surface distress deterioration and also relates to rehabilitation and maintenance needs.

Good 10 to 7	Pavement surface is relatively new with only a few different types of distress present at low severity. Routine maintenance including crack sealing and patching may be required.
Fair 7 to 5	Pavement surface would typically have a minimum of three to four predominant types of distress with varying levels of severity and density. At this condition, pavements would be identified as a rehabilitation need with a wider range of treatments possible.
Poor < 5	Pavement surface condition is in poor condition and deteriorated to the state where substantial rehabilitation is required.

The classification scheme is considered generally applicable for all pavements with no distinction made for different roadway classifications.

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8.0 Pavement Roughness Indices

Pavement roughness is a measure of the riding comfort experienced by the road user. It can be due to deficiencies with the original construction, deterioration from traffic loadings and environmental conditions. It is also affected by a vehicle's suspension and operating speed.

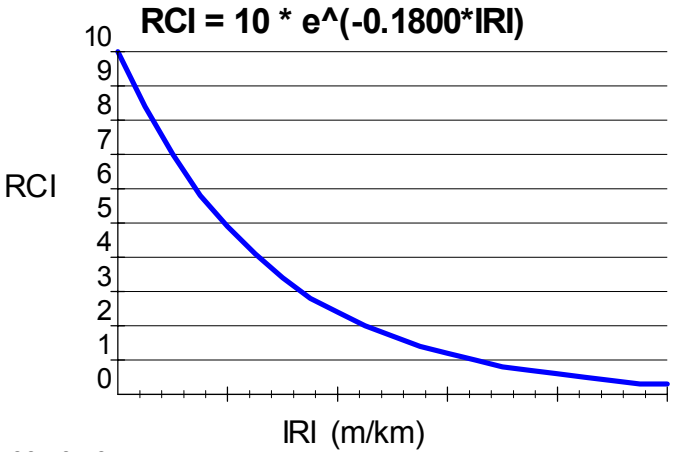
Pavement roughness is the other key corporate performance measure used by the Ministry for asset management purposes including condition monitoring, rehabilitation programming and reporting.

8.1 IRI and RCI Models

As indicated previously, pavement roughness is measured during the RPMS surveys. Continuous longitudinal profile data is collected in each wheel path that consists of thousands of elevation points recorded per kilometre of road surveyed. The profile data is used to calculate the International Roughness Index (IRI) based on the World Bank specifications and has become the standard roughness measurement used by road agencies throughout the world.

The IRI is calculated based on the true profile of the road and intended to represent the roughness qualities that impact vehicle response via its suspension system. The vehicle suspension motion is accumulated and divided by the distance traveled to provide an index, which is reported in units of m/km. For example, an IRI of 0 m/km indicates absolute smoothness, whereas an IRI value of 9 m/km represents an unpaved roadway.

The IRI data is used to calculate the Riding Comfort Index (RCI) which is based on the same 10 to 0 rating scale as the PDI and used for network level reporting. A mathematical model based on research conducted by Paterson (1986) as shown on the next page is used to convert from IRI to RCI. The models can also be modified as required within the RPMS.



8.2 Interpretation

Similar to the PDI, the RCI is based on a declining performance scale from 10 to 0, with three general condition categories as described below.

Good 10 to 7 (IRI 0.0 to 2.0)	Pavement profile is relatively smooth and provides a pleasant, safe and comfortable ride.
Moderate 7 to 5 (IRI 2.0 to 3.8)	Pavement has become moderately rough with noticeable distortion and vertical movement. Rehabilitation may be warranted, but still provides a safe ride at posted speeds.
Rough < 5 (IRI > 3.8)	Pavement is distorted, providing a rough, uncomfortable ride and may be safety issue at higher posted speeds. The level of deterioration requires major rehabilitation.

The classification scheme was developed based on the original TAC riding comfort categories and data analyses. It is considered generally applicable for primary and secondary highways.

9.0 Automated Contract Surveys QA Specifications

9.1 Introduction

Pavement condition data is the most important component of a pavement management system. It is used for determining the present condition of the paved highways and forms the basis for predicting future performance for planning rehabilitation and maintenance.

The pavement surface condition surveys included surface distress ratings, rut depth and roughness measurements in both wheel paths, crack sealing/patching ratings and Super VHS video-logs of the right-of-way.

Like many provincial and municipal agencies, the British Columbia Ministry of Transportation (BCMoT) contracts out the collection of pavement surface condition data. These contractors use multi-function pavement evaluation vehicles that employ automated/semi-automated equipment for measuring surface distress, rutting, roughness, video images, etc. Since 1993, the Ministry has used both Stantec Consulting Limited and Roadware Corporation.

Stantec RT-3000

Roadware ARAN

Because BCMoT is committed to contracts with multiple private contractors, quality assurance (QA) plays a critical role in ensuring that the data is collected accurately and repeatable from year to year.

The Ministry has developed and implemented comprehensive QA procedures that consist of three levels of testing: (a) initial tests completed by the contractor before the surveys commence, (b) blind site monitoring during the production surveys and (c) assessing submitted data files. The following sections describe each.

9.2 Initial Quality Assurance Tests

The initial QA tests are used to ensure that the Contractor is correctly applying the BCMoT pavement surface distress rating system and their roughness/rut-depth instrumentation is operating properly before authorization is given to begin the production surveys. An overview of the initial QA testing follows.

Site Selection

Four test sites are used for the initial QA. The sites are 500 metres in length with a 250 metre lead-in. The sites exhibit a representative variety of distress types, range in pavement deterioration, surface types and operating speed with the intent to be representative of the actual survey conditions.

Typical test site with full traffic control – divided highways are preferred

If possible, the sites are located within close proximity to one another to enable the automated surveys to be conducted in sequence.

Advance Manual Surveys

Manual surface distress, roughness and rut depth surveys are conducted at all of the test sites in advance of the initial QA testing.

Class I Roughness Survey

Manual Distress Survey

Rut Depth Survey

The manual surface distress surveys are done using the Ministry's Pavement Surface Condition Rating Manual by walking the site and rating the distress types present for each 50 metre segment. The rut depth manual survey involves taking manual transverse profile measurements in each wheel path at 10 metre intervals using a 2 metre rut measuring gauge. The longitudinal profile and IRI in each wheel path is obtained using a Digital Profilite 300, which is a Class 1 profiler.

On-Site Review

The purpose of this exercise is to ensure that the Contractor is well versed with the BCMoT surface distress rating methodology if a windshield survey is being conducted (see Section 2.5 for video rating surveys).

The Contractor completes an automated survey over the start-up site and summarizes the distress ratings. The Contractors crew and BCMoT personnel then walk over the site comparing the automated survey results to the manual ratings. The ensuing discussions assist in resolving ambiguities and if necessary, adjustments may be required to the rating procedures and revisions to the manual ratings.

Surface Distress Rating Tests – Windshield Surveys

Surface distress rating tests are completed at all four test sites to assess the Contractors ability to accurately and repeatedly rate pavement distress according to the Ministry rating system. The survey vehicle completes a series of five runs over each site. The distress ratings are generated at 50 metre intervals and compared to the manual values for each run.

Two criteria are used to assess the Contractors surface distress rating ability:

- Pavement Distress Index - calculated using the PAVER model, the PDI value is used to compare the Contractors surveys to the manual surveys and assess the repeatability of the Contractor's surveying.

- Keystroke Totals - severity and density rating totals for each distress type present over the entire site to compare the Contractor's surveys to the manual surveys at a very detailed level to assess the rating accuracy.

Manual Distress Mapping

Automated Distress Survey

A spreadsheet program is used to generate the average PDI value and keystroke totals from the distress ratings for both the manual and automated surveys. The Contractor is required to produce a report with their on-board software that indicates the severity/density ratings for each distress type as shown below.

Figure: Distress Severity and Rating Form

Chainage	LWP		LJC		PEC		TC		MLC		AC		POT		DST		BLD	
(m)	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D
0-50	1	3					2	3										
50-100	1	3					2	3										
100-150	1	3					2	3										
150-200							2	3										
200-250							2	3										
250-300							2	3										
300-350	3	5					2	3					2	2				
350-400	3	5									1	2						
400-450	3	5			3	3					1	2						
450-500	2	5			3	3												

Severity: 1 – Low 2 – Moderate 3 – High **Density**: 1- Few (<10%), 2- Intermittent (10-20%), 3 - Frequent (20-50%), 4 - Extensive (50-80%) and 5 - Throughout (80-100%)

While the PDI is the main criteria used to assess accuracy and repeatability, the keystroke summaries are used as a diagnostic tool to highlight discrepancies between the Contractors and manual severity/density ratings.

Surface Distress Rating Tests – Video Surveys

The QA testing for surface distress rating using a SVHS video based system follows the same principles as outlined for the windshield survey. However, unlike the windshield method, whereby the rating is done during the survey, video rating is generally done following the surveys.

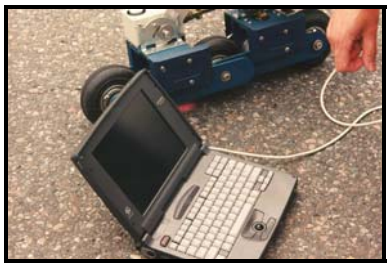
During the initial QA, the contractor shall be required to video record the four test sites and a copy will be provided to the Ministry for subsequent reference. The Contractor shall notify the Ministry when they are ready to begin the video distress rating. At that time, the Ministry representative will review the BCMoT distress rating system via telephone conference call with the Contractors rater(s) to ensure that they are well versed with the methodology. The video distress raters will then rate the start-up site, generate a report showing the severity/density ratings for each distress type and fax the report to the Ministry representative for review.

Via telephone conference call, the video distress rater(s) and Ministry representative will review the SVHS video of the start-up site comparing the video-rated survey results to the manual ratings. The ensuing discussions assist in resolving ambiguities and if necessary, adjustments may be required to the rating procedures.

Following the initial discussion video survey, the Contractor shall be required to conduct surface distress ratings for all four test sites. This shall be done five (5) times for each test site in order to asses both accuracy and repeatability. The reports as previously specified shall be generated and be faxed to the Ministry representative for review as per the acceptance criteria.

Roughness Tests

The roughness testing consists of validating the Contractor's automated surveying equipment by field comparisons to the known longitudinal profile at each test site. The survey vehicle completes a series of five runs over each site to assess both accuracy and repeatability. The IRI values for each wheel path are generated at 50 metre intervals and compared to the manual values.



Comparing roughness measurements from CSC Profilite automated survey for a test site.

The Contractor is required to produce a report with their on-board software that specifies the IRI value for each wheel path at 50 metre intervals. The average IRI value is calculated for each wheel path for the 500 metre test site for review as per the acceptance criteria

Rut Depth Tests

The rut depth QA tests validate the Contractor's automated surveying equipment by field comparisons to the known transverse profiles. The Contractor is required to conduct multiple runs over all four sites to measure the accuracy and repeatability of the rut bar measurements. This test is representative of actual survey conditions as it accounts for the possibility of the survey vehicle wandering over the travel lane. The rut depth values for each wheel path are generated at 50 metre intervals and compared to the manual values for each run.

The Contractor is required to produce a report with their on-board software that specifies the rut depth value for each wheel path at 50 metre intervals. The average rut depth value is calculated for each wheel path for the 500 metre test site for review as per the acceptance criteria

Acceptance Criteria for Initial QA Tests

The quality assurance acceptance criteria for the accuracy and repeatability of the surface distress, roughness and rut depth measurements as part of the initial QA tests are indicated below.

- **Surface Distress**
  Measure: PDI value
  Calculation: lane

Accuracy: +/- 1 PDI value of manual survey
Repeatability: +/- 1 std deviation of the PDI values for five runs

- **Roughness**
  Measure: IRI
  Calculation: every 100 m and 500 m
  Unit: each wheel path
  Accuracy: 10% of Class I profile survey
  Repeatability: 0.1 m/km std deviation for five runs
- **Rut Depth**
  Measure: rut depth (mm)
  Calculation: every 50 m and averaged for 500 m
  Unit: by wheel path
  Accuracy: +/- 3 mm of manual survey
  Repeatability: +/- 3 mm std deviation for five runs

Failure to meet the acceptance criteria may necessitate the following:

- Additional on-site discussions with BCMoT;
- Repeat of automated surveys;
- Equipment repairs/modifications; and/or
- Retraining and/or replacement of rating staff.

Once the Contractor has satisfactorily completed the initial QA testing as described herein, they are authorized to begin the production surveys. BCMoT provides written confirmation.

9.3 Production Survey Quality Assurance

The accuracy of the Contractor's surface condition rating and equipment is also closely monitored during the production surveys as a further measure of quality assurance. This QA is primarily done using blind sites that are situated along various highways in each Region that have been manually surveyed in advance and are of unknown location to the contractor. For larger surveys, the initial QA tests sites are also resurveyed periodically.

Blind Site Locations

The number and location of the blind sites is defined based on the contract quantities and using the Contractors routing schedule, which is provided to BCMoT in advance of the production surveys. Blind sites are generally scheduled once every three days during the surveys.

Advance Manual Surveys

If possible, manual surface distress, roughness and rut depth surveys are conducted at all of the test sites. The surveys are done in advance of the Blind site QA testing. The manual surface distress surveys are done using the Ministry's Pavement Surface Condition Rating Manual by walking the site and rating the distress types present for each 50 metre segment. The same person is used to rate all Blind sites throughout the province to ensure consistency since it is still a subjective analysis.

Class I Roughness Survey


Manual Distress Survey


Rut Depth Survey

The rut depth manual survey involves taking manual transverse profile measurements in each wheel path at 10 metre intervals using a 2 metre rut-measuring gauge. The longitudinal profile and IRI in each wheel path is obtained using a Digital Profilite 300, which is a Class 1 profiler.

Monitoring Process

Each day during the production surveys, the Contractor is required to contact and update the BCMoT representative as to their progress. At this time, the Contractor is informed that they have passed over a site on the previous day and is provided with the site location kilometre chainages.

The surface distress survey ratings, roughness and rut depth measurements are to be immediately submitted to BCMoT by fax and the Contractor is to wait until further notice.

The Contractor is required to produce a report with their on-board software that indicates the distress ratings at 50 metre intervals along with the IRI and rut depth values for each wheel path also reported at 50 metre intervals. For the purposes of this exercise and because of possible referencing differences, the Contractor is required to submit 1.0 kilometre of data with 250 metres on either side of the Blind site. The reports as previously specified shall be generated and faxed to the Ministry representative for review as per the acceptance criteria.

Retest Initial QA Sites

Additional QA testing is carried out during the production surveys for larger projects where the contractor is required to work in multiple regions and/or if the surveys require more than one month to complete.

In these cases, the initial QA test sites are used to verify that the Contractor is correctly applying the BCMoT pavement surface distress rating system and their roughness/rut-depth instrumentation is operating properly. The survey vehicle completes a series of five runs over each site in order to assess both accuracy and repeatability. The data is summarized as noted previously, submitted to BCMoT and compared to the manual values for each run.

The quality assurance acceptance criteria for the accuracy and repeatability of the surface distress, roughness and rut depth measurements of the initial QA tests and remedial requirements are described.

Acceptance Criteria for Blind Site QA Tests

The quality assurance acceptance criteria for the surface distress, roughness and rut depth measurements for blind site QA are indicated below.

- **Surface Distress**
  Measure: PDI value
  Calculation: lane

Accuracy: +/- 1 PDI value of manual survey
Repeatability: +/- 1 std deviation of the PDI values for five runs

- **Roughness**
  Measure: IRI
  Calculation: every 100 m and 500 m
  Unit: each wheel path
  Accuracy: 10% of Class I profile survey
  Repeatability: 0.1 m/km std deviation for five runs

- **Rut Depth**
  Measure: rut depth (mm)
  Calculation: every 50 m and averaged for 500 m
  Unit: by wheel path
  Accuracy: +/- 3 mm of manual survey
  Repeatability: +/- 3 mm std deviation for five runs

Failure to meet the acceptance criteria may necessitate the following:

- Additional on-site discussions with BCMoT;
- Repeat of automated surveys;
- Equipment repairs/modifications; and/or
- Retraining and/or replacement of rating staff.

Once the Contractor has satisfactorily completed the Blind site QA test as described herein, they are authorized to continue with the production surveys.

9.4 Submitted Data Quality Assurance

Quality assurance assessment of submitted data is considered an integral part of the overall survey QA process. The Ministry uses a 3-step process that involves both manual and system checks to assess submitted surface distress, roughness and rut depth data files.

Manual Review

The first step consists of conducting a thorough manual review of the submitted data files and includes verifying the following:

- Data exists for all road segments;
- Highway traversal definitions for all road segments;
- Correct data file structure;
- Start and end boundaries for all road segments
- All lane references and chainages according to Routing Book
- Screening all data for null and negative values
- Screening all data according to max/min tolerance parameters

The initial QA results are summarized and provided to the contractor for correction.

Prior Year Comparison

The second step involves comparing the current year submitted survey data to prior collected data. This provides an effective means to determine if there are any significant variations from cycle to cycle. In the past, network averages by functional class were calculated, but starting in 2001 this is being expanded to include defined sample segments for a more detailed assessment. This is possible since the same road segment directions are surveyed each cycle.

PMS Data Upload Tests

The final step then involves uploading the distress, roughness and rut depth data to the Ministry's corporate pavement management system. The system includes functionality that conduct internal standardized and user defined verification tests. Afterwards, the PMS generates a log report listing all discrepancies which can be reviewed, confirmed and input data corrected and reloaded as required. All of this is documented on file as well for future reference.

9.5 Data File Specifications

FIELD NAME	UNITS	TYPE	WIDTH	DECIMAL
ROUTE_TYPE	-	C	2	-
HIWY_ID	-	N	5	0
AUX_ID	-	C	1	0
DUP_ID	-	N	2	0
DIRECTION	-	C	1	-
START_KM	KM	N	8	3
END_KM	KM	N	8	3
LANE	-	N	1	0
SURVEY_DAT	YYYY/MM/DD	D	8	-
PAVE_TYPE	-	N=1	1	0
LNGC_L	%	N	3	0
LNGC_M	%	N	3	0
LNGC_H	%	N	3	0
LCJT_L	%	N	3	0
LCJT_M	%	N	3	0
LCJT_H	%	N	3	0
EDGE_L	%	N	3	0
EDGE_M	%	N	3	0
EDGE_H	%	N	3	0
TRNC_L	%	N	3	0
TRNC_M	%	N	3	0
TRNC_H	%	N	3	0
MEAN_L	%	N	3	0
MEAN_M	%	N	3	0
MEAN_H	%	N	3	0
ALGC_L	blank	N	3	0
ALGC_M	%	N	3	0
ALGC_H	%	N	3	0
POTH_L	%	N	3	0
POTH_M	%	N	3	0
POTH_H	%	N	3	0
RUTT_L	%	N	3	0
RUTT_M	%	N	3	0
RUTT_H	%	N	3	0
DIST_L	blank	N	3	0
DIST_M	%	N	3	0
DIST_H	%	N	3	0
BLDG_L	blank	N	3	0
BLDG_M	%	N	3	0
BLDG_H	%	N	3	0

FIELD NAME	UNITS	TYPE	WIDTH	DECIMAL
ROUTE_TYPE	-	C	2	-
HIWY_ID	-	N	5	0
AUX_ID	-	C	1	0
DUP_ID	-	N	2	0
DIRECTION	-	C	1	0
START_KM	KM	N	8	3
END_KM	KM	N	8	3
LANE	-	N	1	0
SURVEY_DAT	YYYY/MM/DD	D	8	0
LIRI	-	N	5	2
RIRI	-	N	5	2
LRUT	-	N	2	0
RRUT	-	N	2	0
MAX_LRUT	-	N	2	0
MAX_RRUT	-	N	2	0

Note: If IRI and/or rut depth values cannot be obtained for a segment, a 0 is placed in the field.

FIELD NAME	UNITS	TYPE	WIDTH	DECIMAL
ROUTE_TYPE	-	C	2	-
HIWY_ID	-	N	5	0
AUX_ID	-	C	1	0
DUP_ID	-	C	1	0
DIRECTION	-	C	1	0
START_KM	KM	N	8	3
END_KM	KM	N	8	3
LANE	-	N	1	0
SURVEY_DAT	YYYY/MM/DD	D	8	0
S1	-	N	3	0
S2	-	N	3	0
S3	-	N	3	0
S4	-	N	3	0
S5	-	N	3	0
S6	-	N	3	0
S7	-	N	3	0
S8	-	N	3	0
S9	-	N	3	0
S10	-	N	3	0

Note: Sensor measurements are to proceed from left (centerline) to right (shoulder) in this file

9.6 Super VHS Video- Log Specifications

View

Right-of-Way (ROW) view - continuous images of the full pavement width, shoulders and roadside features such as signs, structures and guardrails. The horizon line should be approximately 2/3 from bottom of the image.

Resolution

The ROW view is continuous high-resolution color image.

Roof Mounted Camera

Internally Mounted Camera

Media

The recording media is Super VHS videotape.

Encoded Information

The following header information shall be encoded on the video image: Region number Highway route number, Direction, Lane number, Km chainage (0000.000) and Date of survey.

Video Tape Catalogue

The video tape catalogue shall indicate the following information: Tape number, Region number, Highway route number, Direction, Lane number, Chainage Start, Chainage End, Tape Start (hrs:min:sec) and Tape end (hrs:min:sec).

Review of Trial Images

During the initial QA testing, the camera angles and magnification will be adjusted and defined by a series of test runs with the Ministry representative to determine the appropriate views.

Once the appropriate view has been established, the Contractor must take all necessary measures to ensure that the image angle and magnification remain consistent throughout the production surveys. This is particularly critical if the SVHS recording system requires either of the cameras to be dismounted and remounted each day.

Quality Assurance

During the production surveys, the Contractor will be periodically requested (approximately once every week) to provide the Ministry representative with a sample copy from the ongoing survey for review. The Super VHS tape shall be sent to the Ministry representative via courier for review.

The overall quality of the image must be acceptable as well as the composition of the images. This review will ensure that the correct camera positions and field of view are being captured as well as general adherence to the specifications. The survey crew shall be notified of any changes required.

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10.0 Pavement Condition Forms

The following forms are provided for reference purposes and for conducting manual surface distress rating surveys:

- Pavement Distress Rating System – Severity Levels
- Pavement Distress Rating System – Density Levels
- Pavement Distress Survey – Evaluation Form
- Pavement Distress Survey – Crack Mapping Form

Pavement Distress Rating System – Severity Levels

Distress Type	Low Severity	Moderate Severity	High Severity
Longitudinal Wheel Path Cracking (LWP)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Longitudinal Joint Cracking (LJC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Pavement Edge Cracking (PEC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Transverse Cracking (TC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Meandering Longitudinal Cracking (MLC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Alligator Cracking (AC)	Not rated	Interconnected cracks forming a complete block pattern; slight spalling and no pumping	Interconnected cracks forming a complete block pattern, moderate to severe spalling, pieces may move and pumping may exist
Rutting (RUT)	Less than 10mm	10 to 20mm	Greater than 20mm
Shoving (SHV)	Barely noticeable to noticeable	Rough ride	Very rough ride
Distortion (DST)	Not rated	Noticeable swaying motion; good car control	Fair to Poor car control
Bleeding (BLD)	Not rated	Distinctive appearance with free excess asphalt	Free asphalt gives pavement surface a wet look; tire marks are evident
Potholes (POT)	Less than 25mm deep	25 to 50mm deep	Greater than 50mm deep
Ravelling (RAV)	Not rated	Aggregate and/or binder worn away; surface texture rough and pitted; loose particles exist	Aggregate and/or binder worn away; surface texture is very rough and pitted

Pavement Distress Rating System – Density Levels

Distress Type	Units	Few	Intermittent	Frequent	Extensive	Throughout
Longitudinal Wheel Path Cracking (LWP)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Longitudinal Joint Cracking (LJC)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Pavement Edge Cracking (PEC)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Transverse Cracking (TC)	Spacing	10 - 20 m	7 - 10 m	4 - 7 m	2 - 4 m	< 2 m
Meandering Longitudinal Cracking (MLC)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Alligator Cracking (AC)	Area	< 10%	10-20%	20-50%	50-80%	80-100%
Rutting (RUT)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Shoving (SHV)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Distortion (DST)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Bleeding (BLD)	Length	< 10%	10-20%	20-50%	50-80%	80-100%
Potholes (POT)	Number	1	2	3 to 5	6 to 9	> 10
Ravelling (RAV)	Length	< 10%	10-20%	20-50%	50-80%	80-100%

Pavement Distress Survey – Evaluation Form

Page ___ of ___

Rater:	**Road #:**	**Name:**	**Drainage**: A B U
Date:	**Start:**	**Lane #:**	**Sealing:** L1 L2 L3
Weather/Temp:	**End:**	**Width:**	**Patching:** L1 L2 L3

Distress Types		Severity Levels			Density Levels					
						Low	Intermittent	Frequent	Extensive	Throughout
		L	M	H	Units	>10%	10-20%	20-50%	50-80%	80-100%
Longitudinal Wheel Path Cracking	LWP				Length					
Longitudinal Joint Cracking	LJC				Length					
Pavement Edge Cracking	PEC				Length					
Transverse Cracking	TC				Spacing	10-20 m	7-10 m	4-7 m	2-4 m	< 2 m
Meandering Longitudinal Cracking	MLC				Length					
Alligator Cracking	AC				Area					
Rutting	RUT				Length					
Shoving	SHV				Length					
Distortion	DST				Length					
Bleeding	BLD				Length					
Potholes	POT				No.	1	2	3 to 5	6 to 9	> 10
Ravelling	RAV				Length					

Comments:

Pavement Distress Survey – Crack Mapping Form

Road #:_____ Name:_____ Dir: N S E W

IWP	OWP	m
		m
		m
		m
		m
		m

Start Km: _____ Lane#_____ Page ____ of ____