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# Pavement Condition Index (PCI) for Flexible Pavements

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Ministry of Transportation

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# Documentation Page PAV-86-02

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**Abstract:**

Pavement Condition Index (PCI) is a new measure of pavement performance for rating pavements with asphalt concrete surfaces. The PCI comprises two components:
1) Riding Comfort Rating (RCR) for roughness, and
2) Distress Manifestation Index (DMI) for pavement surface distresses.
The RCR is based on objective measurements of roughness derived from mechanical devices. The DMI is obtained by visually evaluating pavement surface distresses according to standard procedures taking into account the type, severity and density of observed distresses.

The report contains detailed guidelines and procedures for determining DMI and provides a general equation for combining the RCR and DMI components:

PCI = constant x (0.1 RCR) 1/2 • ((205 - DMI) ÷ 205)

PCI is designed to supersede the previously-used Pavement Condition Rating (PCR) and PCI is, on average, numerically equal to PCR. However, because PCI is derived more objectively and is a more consistent measure of pavement performance, there may be substantial differences between the two measures on an individual pavement section.

**Comments:**

**Key Words:** pavement design, pavement performance evaluation, ride comfort, asphalt concrete, Mays meter, PURD

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# 1/INTRODUCTION

Traditionally, pavement performance measures have been defined as an assessment of how well the pavement serves the travelling public. For this reason, pavement performance has been primarily measured in terms of roughness. For example, the original AASHO Road Test study of the early 1960s attributed about 95% of pavement performance to the influence of roughness [1] and the remaining 5% to the influence of other factors such as rutting and cracking. This type of pavement performance definition is referred to as functional pavement performance.

With the growing emphasis on pavement preservation of mature highway networks in an environment of fiscal constraint, it is desirable to measure pavement performance also in terms of pavement distresses which may cause an accelerated loss of pavement serviceability and/or distresses triggering pavement preservation actions. The pavement roughness alone is often insufficient for timely selection of specific pavement preservation actions. For example, routing and sealing of transverse cracks may be required to protect the pavement structure even though the presence of cracks has not yet influenced pavement roughness. This emphasis on pavement preservation from the owner's viewpoint must be reflected in the way pavement performance is measured. Pavement performance based on evaluation of pavement distresses has been called structural pavement performance [2]. Structural pavement performance is characteristically used for evaluating highway networks with structurally adequate pavements [3].

The two pavement performance measures -- functional performance and structural performance -- do not conflict as much as they may appear to because pavement distresses and roughness are interrelated. The two measures mainly indicate that different demands may be placed on the measure of pavement performance by different users. Administrators may require the measure of pavement performance:

- To optimize allocation of available funds.
- To provide quantitative data for planning and programming of pavement preservation actions.
- To provide information on a relative condition of the network.

Pavement design and maintenance engineers may require the measure:

- To provide specific data to determine the most appropriate preservation treatment and the optimal time for its implementation.
- To provide feedback information for pavement design.

In order to permit a systematic evaluation and ordering of pavement preservation plans and actions, it is necessary to work with a single measure of performance. The use of several performance measures would make the task of selecting the most desirable strategy extremely complex [3]. Also, it is generally recognized that the use of a single pavement performance indicator can provide a valid measure of pavement performance provided that the methods and factors used in constructing this indicator are appropriate for local conditions and pavement management objectives.

The new pavement performance rating index proposed for the Ministry, the Pavement Condition Index (PCI), reflects the preceding pavement evaluation philosophy. It is a single pavement performance indicator comprising two components:

- a roughness component in the form of Riding Comfort Rating (RCR), which measures the functional performance of the pavement; and
- a distress component in the form of Distress Manifestation Index (DMI), which is mainly related to the structural performance of the pavement.

The components of the PCI can also be used as separate measures of the two types of pavement performance.

The purpose of this report is to briefly summarize the methodology used in constructing the PCI, to provide a detailed description and guidelines for its determination, and to discuss some of the advantages and consequences of using PCI rather than the previously-used Pavement Condition Rating.

The PCI is currently defined only for pavements with asphalt concrete surfaces.

## 2/ REASONS FOR INTRODUCING PAVEMENT CONDITION INDEX

The Ministry has been systematically rating pavement performance since the mid-1960s using the subjectively-assigned Pavement Condition Rating (PCR). The PCR was originally developed to facilitate pavement rehabilitation design, and while its nature has remained unchanged, its use has been greatly expanded. The PCR is now used to allocate budgets in the most cost-effective manner [4], to program pavement rehabilitation actions and as a key pavement performance feedback for pavement design purposes [5].

It was realized, in the 1970s, that pavement performance evaluation should be done using a more objective and better defined measure [6,7]. The measure suggested was called Distress Index (DI), it used a scale of 0 to 100, and comprised a roughness component and a distress component. The PCI inherits the concept of the DI with some important modifications:

a) The PCI roughness component is based on mechanical measurements using modern technology rather than on the subjective rating allowed for the DI.

b) The PCI distress component is based on 15 pavement distresses rather than on the 27 distresses used for the DI.

In summary, the PCI replaces the previously-used pavement performance rating measures (PCR and DI) to provide a more objective and reliable measure of pavement performance (see note below). The use of PCI will improve the reproducibility and reliability of pavement performance rating and should enhance its authoritativeness and acceptability.

**Note:** A concurrent study on the structure of the PCI [8] indicates that only about 71% of the PCR variance can be explained using objectively determined pavement performance characteristics such as measured pavement roughness and observed pavement distresses. A further 10% of the PCR variance could be explained by pavement age and traffic volume, even though these two variables should not be considered when determining the PCR. The rest of the PCR variance (19%) could not be attributed.

## 3/ PCI COMPONENTS

The Pavement Condition Index comprises two different physical parameters:

a) the riding quality of the pavement surface as perceived by the travelling public, and
b) the extent and severity of pavement distress manifestations. Distress manifestations are defined as visible consequences of various pavement distress mechanisms which usually lead to a reduction in pavement performance.

Both components are obtained by evaluating the total length of the pavement section rated. Each section should be selected to exhibit a uniform pavement performance.

The two PCI components do not represent separate entities. The components are both correlated and interrelated. Many distresses are accompanied by distortion or surface uneveness. For example, the presence of severe transverse cracking usually coincides (correlates) with increased pavement roughness. The increased roughness, in turn, interacts with transverse cracks producing higher dynamic wheel loads in the vicinity of cracks where the pavement structure is already weakened and the increased and concentrated strains and stresses further hasten crack deterioration. However, the two components are evaluated using different techniques and for somewhat different reasons (as discussed in the Introduction).

### 3.1/ Riding Comfort Rating (RCR)

The Riding Comfort Rating (RCR) is often the most important and influential component of the PCI. It is a perceived measure of roadway roughness as experienced by the public. As a perceived measure, RCR has been traditionally evaluated subjectively and rated on the scale from 0 to 10. However, because the present mechanical devices enable an objective, repeatable and reliable measurement of vehicular response to roughness on a routine basis, the RCR, for the purposes of the PCI, should be established by mechanical measurements.

Vehicular response to roughness obtained by any mechanical device must still be related back to a human response to roughness expressed in terms of the RCR.

Two mechanical roughness measurement devices have been routinely used by MTC in the past: a Mays Ride Meter (Mays) [9] and a Portable Universal Roughness Device (PURD) [10]. Considering the latter as an example, the vehicular roughness measurement in terms of root-mean square vertical acceleration of a typical passenger car axle in $m/sec^2$, must be related to the roughness perceived by the occupants of the vehicle in terms of the RCR measured on the scale from 0 to 10. The mathematical relationship between the two responses is referred to as a transfer function. In order to develop transfer functions linking the vehicular response to roughness measured by the Mays and PURD devices, a roughness measurement study was undertaken.

### 3.1.1/ Roughness Study

Extensive pavement roughness measurements were carried out on the highway networks of three MTC Districts, Huntsville, Kingston and Stratford, in 1984. Both Mays and PURD measurement devices were used. The three Districts were selected with the intention of obtaining a province-wide representative sample of distress manifestations and roughness conditions associated with a variety of pavement structures and traffic and environmental exposures. All asphalt concrete pavements on King's Highways in the three Districts (about 3270 centreline-km) were included in the study. Two-lane highways were measured in one direction only; divided highways were measured in both directions.

The average roughness measurements were obtained for each highway section with the known, previously established, RCR. The RCR was determined subjectively by different raters in each District. All raters were experienced and were familiar with their respective Districts. The highway sections were considered to have a uniform pavement performance. The section length ranged from 0.3 to 25.7 km with an average of 9.9 km. The total number of highway sections included in the study was 310.

### 3.1.2/ Transfer Functions

The search for the best transfer functions was done by formulating many promising mathematical models, relating the mechanically-measured roughness with the RCR, and evaluating them using the least-square regression technique. The results for two typical model formulations, a linear and a semi-logarithmic, are summarized in Table 1 in terms of R-square. R-square multiplied by 100 yields percentage of the variance explained by the regression model. The results suggest that roughness measured by PURD correlates marginally better with the RCR than the roughness measured by Mays meter. Also, for PURD, the semi-logarithmic model formulation is marginally better than the linear one. For the Mays meter, the linear model formulation appears to be marginally better.

Based on the results of the roughness study, the following transfer functions are recommended:

a) For PURD:

$$RCR = 14.85 - 6.18 \cdot \log_{10}(PURD) \qquad (1)$$

where: RCR = Riding Comfort Rating of an entire highway section

$$PURD = \frac{\sum_{i=1}^{n} SV}{n}$$

SV = Slope variance computed from profile elevations on 50 m long section segment [11]

n = number of 50 m segments contained in the highway section

b) For Mays

$$RCR = 9.38 - 0.0177\ (Mays) \qquad (2)$$

where: RCR was defined for Equation 1, and

$$Mays = \frac{\sum_{i=1}^{n} RAM}{n}$$

RAM = Relative axle movement as defined in Reference 9 obtained for 0.8 km long section segment

n = number of 0.8 km long segments contained in the highway section.

The transfer function defined by Equation 1 is illustrated in Figure 1 which also shows a corresponding transfer function established in 1979 using a generically identical mechanical device [12]. Both functions have a similar shape; however, the present function is slightly shifted upwards. This indicates that, in order to achieve long-term stability in measuring the RCR, the roughness measuring equipment must be carefully calibrated and any unavoidable changes in its mechanical components must be noted and their influence carefully assessed.

The use of the two roughness measurement devices and their respectiv transfer functions will yield, on the average, the same RCRs as thre e assigned subjectively. However, for the individual pavement se t ons, there may be considerable differences between the objectively an subjectively assigned RCRs. Furthermore, there are also dif er nces between the RCRs obtained by different roughness measuremen vices. For example, R-square for a linear model relating Mays and P D was 0.80. This indicates that 20% of the variance between the two dev es was not explained by the model. The unexplained variance can b c used by the differences in the measured physical responses, differ nc s in the equipment (e.g., tire type, weight and suspension of tr ilers) and by other factors. At any rate, in order to obtain reliab e and historically stable roughness measurements, only one type of ro gh ess measurement device should be used for establishing the PCI. n recommended device is PURD. PURD measurement instrumentation has b e recently changed. Instead of slope variance, the PURD now measures oot-mean square vertical acceleration in m/sec$^2$.

**Note:** The function relating the new PURD mea urements (NEW PURD) with the original PURD measurements (PURD) is:

$$\text{NEW PURD} = 73.0 + 20.6\ (\text{PURD}) \quad (3a)$$

The R-square of this function, based on 3 measurements, was 0.95. NEW PURD is given in 0.001 m/sec$^2$. The unction relating RCR and NEW PURD is:

$$\text{RCR} = 26.6 - 7.34 \log_{10}\ (\text{NEW PURD}) \quad (3b)$$

### 3.2/ Distress Manifestation Index (DMI)

A systematic method for classifying and assessing visible consequences of various distress mechanisms (i.e., distress manifestations) was developed in 1975 [6] and its use commenced Ministry-wide in 1978. The method classifies distress manifestations into 27 distress categories. Each category of distress is further characterized by its severity and density. To ensure uniformity of interpretation and reporting, a comprehensive manual was prepared [7]. The manual provides detailed guidelines, accompanied by many photographs, showing how to classify distress manifestations and how to evaluate their severity and density so that these characteristics can be expressed on ratio scales from 0 to 4.

The above methodology of classifying and evaluating distress manifestations has been kept. However, based on experience gained since 1978, the number of distress manifestation categories has been reduced from 27 to 15. The reduction was achieved by combining 2 or 3 similar distresses into one. For example, the two distress categories "rippling" and "shoving" were combined into one. The new 15 distress manifestation categories are listed in Table 2.

In order to summarize the influence of the 27 distresses and to express this influence as one number, a DM (Distress Manifestations) characteristic was developed in Reference 7. Reduction of the number of distresses from 27 to 15 necessitated changes in the calculation of the overall DM characteristic, now based on 15 distress manifestation categories and referred to as Distress Manifestation Index (DMI).

#### 3.2.1/ Calculation of DMI

The formula developed for calculation of the Distress Manifestation Index has a structure similar to that used for calculating DM [7]. The formula is based on application of the utility theory. This enables us to put all distresses on the same scale and combine their contribution in terms of the DMI:

$$DMI = \sum_{i=1}^{n} w_i(s_i + d_i) \qquad (4)$$

where: DMI = Distress Manifestation Index. DMI is an overall characteristic (or a multi-attribute utility) describing pavement surface condition in terms of distress manifestations.

$w_i$ = Weighting value representing the relative weight of each distress manifestation (attribute) given in Table 2.

$s_i$ = Severity of distress manifestations expressed on a scale from 0 to 4 as given in Table 2.

$d_i$ = Density of distress occurrence expressed on a scale from 0 to 4 as given in Table 2. The sum of $(s_i + d_i)$ represents the contribution or utility of each distress (attribute) scaled from 0 to 8.

The weighting values ($w_i$) were chosen using expert opinions and by calibration techniques to represent the perceived contribution of different distresses to the overall DMI, and ultimately to the PCI. For example, centreline alligator cracking has a $w_i$ equal to 2, while longitudinal wheel track alligator cracking has a $w_i$ equal to 3. In other words, cracking in the wheel track is considered to contribute 50% more to the DMI than cracking along the centreline. The weighting values are not intended to capture pavement roughness components already accounted for by the RCR. This may explain, for example, the relatively low weight (1.0) given to half, full and multiple transverse cracking.

The weighting values of the 15 distresses given in Table 2 were also tested to ensure that the DMI is equal to the previously-used DM based on 27 distresses. All DMs recorded during the period from 1978 to 1985 have been converted to DMIs. The conversion was done by combining densities and severities of corresponding distresses and encompassed approximately 5800 observations. The R-square of the linear relationship between the old DM and the new DMI was 0.938.

**3.2.2/ Procedure for Determining DMI**

Step 1, Field Survey

The basic procedure for classifying and rating pavement distresses described in "Manual for Condition Rating of Flexible Pavements" [7] remains the same; however, only 15 separate distress categories are identified and evaluated. The evaluation should be done using the Flexible Pavement Condition Evaluation Form shown in Figure 2. Detailed guidelines for completing the Flexible Pavement Condition Evaluation Form are given in Appendix A.

In addition to facilitating the pavement distress evaluation, the form provides a structured format for the evaluation of shoulder performance (for paved, surface treated and primed shoulders only) and for recording the extent of past pavement maintenance treatments. However, the performance of shoulders and the extent of pavement maintenance treatments are not directly used for the determination of the DMI.

The form must be completed by knowledgeable personnel who can properly classify various distresses and rate their extent. Preferably, the evaluation of pavement distresses should be done by the same personnel who is responsible for designing and recommending pavement preservation treatments, i.e., Regional Geotechnical staff. Such practice enables the raters not only to observe the occurrence of distresses, but also to determine their underlying causes, and it promotes understanding of the relationship between structural characteristics of the pavement and its field performance.

Step 2, Calculation of DMI

The DMI is calculated by substituting the field-recorded data and the distress weighting values into Equation 3.

**3.2.3/ Use and Limitations of DMI**

The DMI is an integral part of the PCI but the DMI can also be used independently as the measure of visible pavement distresses. The DMI, or particularly some of its components, can be used as a proxy for assessing pavement structural adequacy and for identifying pavement sections which may require a corrective action due to specific distress conditions.

The typical frequency of distresses which encompass the DMI is shown in Figure 3. The figure shows 1984 conditions for the Districts used in the roughness study (Huntsville, Kingston and Stratford). As such, it illustrates distress conditions on about 3270 highway-km divided into 310 sections. The frequency of each distress is shown for three levels of distress contribution. These are ($s_i + d_i$) defined for Equation 3:

- 1 and more,
- 2 and more, and
- 4 and more.

The most frequent distress encountered in the three Districts was (half, full and multiple) transverse cracking. About 90% of all highway sections had an $s_i + d_i$ contribution of at least 1 or, in the standardized descriptive terminology given in Reference 7, about 90% of all highway sections had at least <u>few very slight</u> (half, full and multiple) transverse cracks. About 55% of all sections had an $s_i + d_i$ contribution of at least 4 -- they had, typically, at least <u>frequent moderate</u> (half, full and multiple) transverse cracks.

Even though the DMI includes 15 distress manifestation categories, each of them characterized by its weighting value and by its severity and density, the DMI still cannot fully assess all pavement surface conditions which may be encountered in the field. For example, some types of wheel track rutting or asphalt concrete flushing can constitute a safety hazard and their existence alone can justify a corrective action. However, the existence of these conditions would not alone sufficiently reduce the DMI or the PCI values to indicate that a corrective action is required. For this reason, all unusual distress conditions should be recorded on the Flexible Pavement Condition Evaluation Form (Figure 2) under "Distress Comments".

## 4/ PCI CALCULATION

The Pavement Condition Index (PCI) combines the influence of RCR and DMI using the following equation:

$$PCI = 100(0.1\ RCR)^{1/2}\ \frac{(205-DMI)}{205} \cdot c + s \qquad (5)$$

where: $PCI \leq 100$

RCR = Riding Comfort Rating.
RCR should be calculated using Equation 1, i.e., it should be based on PURD Measurements. If the PURD-derived RCR is not available, subjectively-assigned RCR may be substituted to approximate PCI. (Refer also to calibration constant c, defined below.)

DMI = Distress Manifestation Index calculated by Equation 3

205 = Probable maximum value of DMI

c,s = Calibration constants

c = 1.077 and s = 0 if RCR is measured by PURD and calculated by Eq. 1

c = 0.924 and s = 8.856 if RCR is established subjectively to approximate PCI.

Note that Equation 5 has the same structure as that proposed for DI (Distress Index) in Reference 7. The calibration constant c, exponent of 1/2, and the constant of 205 ensure that, on average, the PCI is equal to the Pavement Performance Rating (PCR) and that a linear model relating PCI and PCR has a slope equal to 1 and an intercept equal to 0. In other words, on average, the PCI is numerically equal to the PCR. The R-square of the linear model relating PCI with PCR, based on the 298 highway sections used in the roughness study, for which all pertinent data were available, was 0.72. The overall degree of fit between PCI and PCR is shown by the plot given in Figure 4.

The relationship of Equation 5 is graphically illustrated in Figure 5 which represents a monograph for calculating PCI. For example Figure 5 shows that a pavement section with the RCR equal to 7 may have a PCI as high as 90 if its DMI is equal to 0.

## 5/ TRANSITION FROM PCR TO PCI

To obtain full benefits from any pavement condition rating scheme, the scheme must be used consistently over a period of many years. A consistent long-term pavement condition monitoring permits one to:

a) evaluate pavement network condition and its historical trends, and
b) monitor the performance of individual sections using pavement performance curves.

It is also essential as a design feedback for pavement structural design and for pavement performance prediction.

Since, on average, the PCI is numerically equal to the PCR, no major problems should be encountered with the transition for network evaluation or for purposes of design feedback and performance prediction. However, the situation is somewhat complicated for the performance monitoring of individual pavement sections.

The possible consequences of the transition from PCR to PCI for individual sections are illustrated in Figure 6 using three arbitrarily selected highway sections. Two pavement performance curves are shown for all three sections of Figure 6:

a) performance curve in terms of the PCR, and
b) performance curve in terms of the PCI.

Actually, only the PCI values plotted for 1984 used RCR based on PURD roughness measurements and thus only these can be considered to be proper PCI values. For the rest of the PCI values plotted in Figure 6 (i.e., values predating 1984), the PURD-based roughness was not available and their RCRs were assigned subjectively. All PCI values were calculated using Equation 5.

The results indicate that for individual sections there may be considerable differences between the PCI and PCR measures. These differences are inevitable due to the subjective nature of the PCR. The two measures should not be mixed when analysing pavement performance data for individual sections.

## 6/ USE OF PCI FOR PLANNING OF PAVEMENT REHABILITATION TREATMENTS

The PCI can be used for planning of pavement rehabilitation treatments in a manner similar to that used for the PCR. A recent analysis of the 1985 program -- based on the existing pavement conditions of the entire network and on the available funding -- indicated that the range of minimum acceptable PCI levels given in Table 3 is practicable. These minimum levels are believed to conform to current standards of public acceptability. The levels are subject to availability of funds for pavement rehabilitation, and can be changed depending on local conditions, such as traffic volume, pavement structure, and pavement performance. In principle, the minimum acceptable levels are based on the premise that acceptable pavement performance changes with the functional classification of the highway.

In order to ensure that pavements are rehabilitated before minimum acceptable levels are reached, the pavement sections should be placed on a pavement rehabilitation program at least five years before these levels are expected to occur. Because the rate of pavement deterioration is known to vary widely, it is impossible to provide reliable guidelines for placing pavement sections on the pavement rehabilitation program. However, assuming that pavements deteriorate at the rate of three PCI units per year, the range of PCI levels which may warrant the placement of pavement sections on a five-year plan is also given in Table 3.

## 7/ CONCLUSIONS AND RECOMMENDATIONS

1/ The proposed PCI provides a more objective and rational measure of pavement performance than the PCR.

2/ The PCI components, RCR and DMI, can be used independently for pavement management purposes. The RCR is strongly related to the way the pavement serves the travelling public while the DMI is indicative of pavement preservation needs as perceived by a highway agency.

3/ To ensure that the PCI remains a reliable and consistent long-term pavement performance measure, its roughness component must be evaluated using only one type of roughness measurement device. The recommended device is the Portable Universal Roughness Device (PURD).

4/ The evaluation of pavement distresses must be done by knowledgeable personnel, preferably those responsible for designing and recommending pavement preservation treatments.

5/ A PCI, similar to that developed for asphalt concrete pavements, should also be developed for rigid and surface treated pavements.

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**Table 1/ Evaluation of Roughness Transfer Functions**

| ROUGHNESS DEVICE | MTC DISTRICT | NO. OF OBS. | R-SQUARE[1] | |
|---|---|---|---|---|
| | | | Linear[2] Form | Semi-Log[3] Form |
| PURD | Huntsville | 55 | 0.410 | 0.439 |
| | Kingston | 132 | 0.452 | 0.469 |
| | Stratford | 123 | 0.424 | 0.439 |
| | All 3 Districts Combined | 310 | 0.403 | 0.413 |
| MAYS | Huntsville | 55 | 0.454 | 0.450 |
| | Kingston | 132 | 0.530 | 0.512 |
| | Stratford | 123 | 0.390 | 0.400 |
| | All 3 Districts Combined | 310 | 0.401 | 0.378 |

1 Squared multiple correlation coefficient

2 Linear form: RCR = $c_0 + c_1$ (device response)

3/ Semi-logarithmic form: RCR = $c_0 + c_1 \log_{10}$ (device response)

## Table 2/ Assessment of Distress Manifestations

Weighting values, $w_i$

| | DESCRIPTION OF DISTRESS | | WEIGHTING VALUE $w_i$ |
|---|---|---|---|
| SURFACE DEFECTS | 1/ Ravelling and Coarse Aggregate Loss | | 3.0 |
| | 2/ Flushing | | 0.5 |
| | 3/ Rippling and Shoving | | 1.0 |
| SURFACE DEFORMATION | 4/ Wheel Track Rutting | | 3.0 |
| | 5/ Distortion | | 3.0 |
| CRACKING | 6/ Longitudinal Wheel Track | - Single - Multiple | 1.0 |
| | 7/ Longitudinal Wheel Track | - Alligator | 3.0 |
| | 8/ Centreline | - Single - Multiple | 0.5 |
| | 9/ Centreline | - Alligator | 2.0 |
| | 10/ Pavement Edge | - Single - Multiple | 0.5 |
| | 11/ Pavement Edge | - Alligator | 1.5 |
| | 12/ Transverse | - Half - Full- Mult. | 1.0 |
| | 13/ Transverse | - Alligator | 3.0 |
| | 14/ Longitudinal Meander and Midlane | | 1.0 |
| | 15/ Random | | 0.5 |

Severity of Distress, $s_i$

| Description | $s_i$ |
|---|---|
| Very slight | 0.5 |
| Slight | 1 |
| Moderate | 2 |
| Severe | 3 |
| Very Severe | 4 |

Density of Distress, $d_i$

| Description | Percentage | $d_i$ |
|---|---|---|
| Few | <10 | 0.5 |
| Intermittent | 10-20 | 1 |
| Frequent | 20-50 | 2 |
| Extensive | 50-80 | 3 |
| Throughout | >80 | 4 |

**Table 3/ Planning of Pavement Rehabilitation Treatments**

| Facility | Recommended Range of Minimum Acceptable PCI Levels[1] | Recommended Range in PCI Levels[1] for Project in the 5-year Plan |
|---|---|---|
| King's Highways | | |
| Freeways | 60 - 65 | 60 - 80 |
| Arterials | 55 - 60 | 55 - 75 |
| Collectors | 50 - 55 | 50 - 70 |
| Locals | 45 - 50 | 45 - 65 |
| Secondary Highways | | |
| Major | 50 - 55 | 50 - 70 |
| Intermediate | 45 - 50 | 45 - 65 |
| Minor | 45 - 50 | 45 - 65 |

[1]These levels are subject to revision.

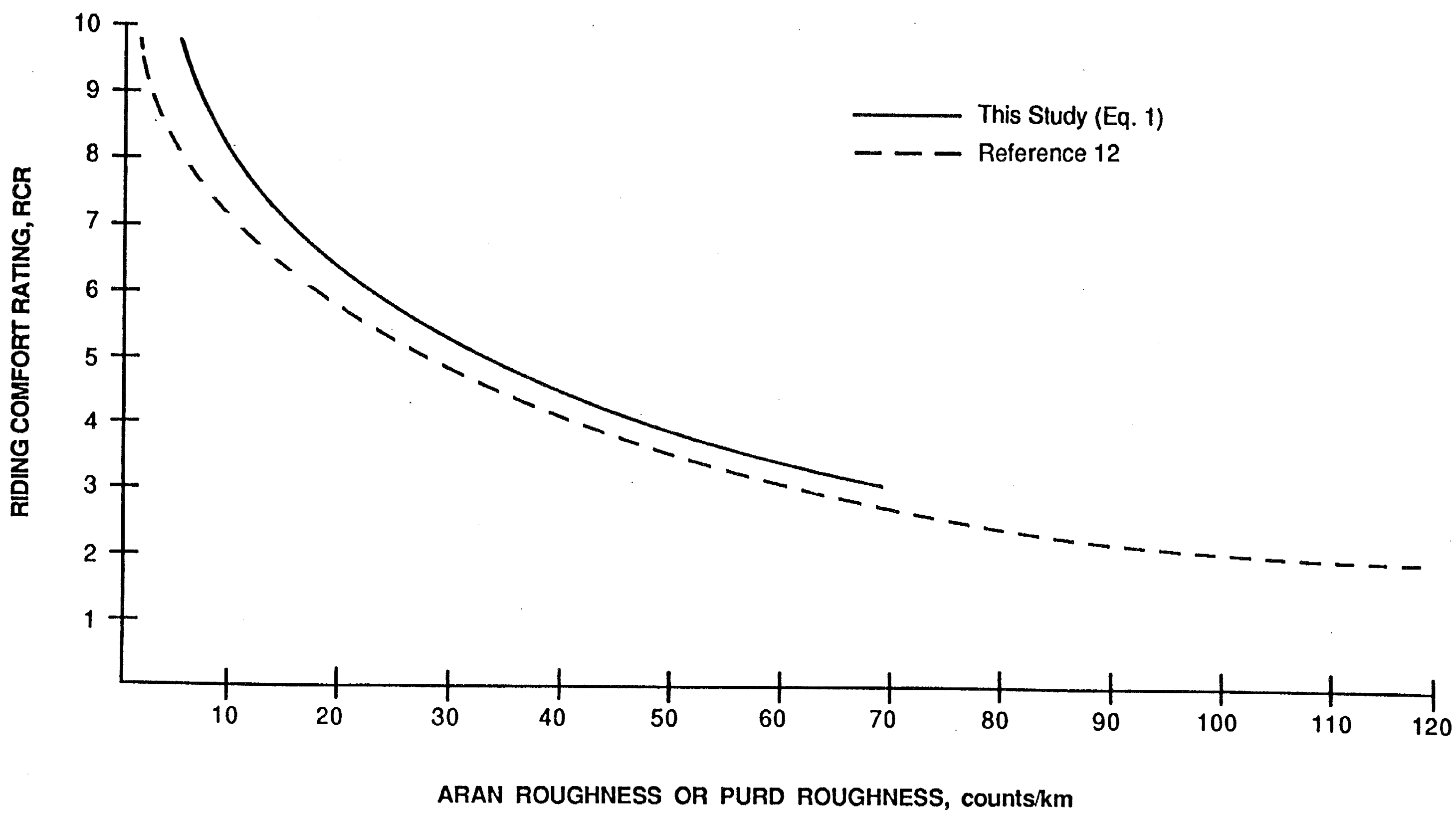


Figure 1/ Transfer Functions for PURD-Based Roughness Measuring Devices

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# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From ____________________ To: ____________________

LHRS [ ][ ][ ][ ][ ] (BEGINS) [ ][ ][•][ ] (OFFSET) km

Section Length [ ][ ][•][ ] (LENGTH) km

District [ ][ ]

Survey Date [ ][ ] (YEAR) [ ][ ] (MONTH)

PCR [ ][ ][ ]

RCR [ ][•][ ]

Traffic Direction [ ] — B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND

Highway [ ][ ][ ][ ]

Contract No. [ ][ ]–[ ][ ][ ]

WP No. [ ][ ][ ][ ]–[ ][ ]–[ ][ ][ ]

Facility [ ] — A : ALL LANES; C : COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes)

Class [ ] — F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY

**Riding Comfort Rating (At 80 km/h)**

- 10–8: EXCELLENT — Smooth and Pleasant
- 8–6: GOOD — Comfortable
- 6–4: FAIR — Uncomfortable
- 4–2: POOR — Very Rough and Bumpy
- 2–0: VERY POOR — Dangerous at 80 km/h

| Pavement | | | Severity of Distress: Very Slight | Slight | Moderate | Severe | Very Severe | Density of Distress (Extent of Occurrence, %): Few <10 | Intermittent 10-20 | Frequent 20-50 | Extensive 50-80 | Throughout 80-100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | | | | | | | | | | |
| | Flushing | 2 | | | | | | | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | | | | | | | | | |
| | Wheel Track Rutting | 4 | | | | | | | | | | |
| | Distortion | 5 | | | | | | | | | | |
| CRACKING – Longitudinal Wheel Track | Single and Multiple | 6 | | | | | | | | | | |
| | Alligator | 7 | | | | | | | | | | |
| CRACKING – Centreline | Single and Multiple | 8 | | | | | | | | | | |
| | Alligator | 9 | | | | | | | | | | |
| CRACKING – Pavement Edge | Single and Multiple | 10 | | | | | | | | | | |
| | Alligator | 11 | | | | | | | | | | |
| CRACKING – Transverse | Half, Full and Multiple | 12 | | | | | | | | | | |
| | Alligator | 13 | | | | | | | | | | |
| CRACKING | Longitudinal Meander and Midlane | 14 | | | | | | | | | | |
| CRACKING | Random | 15 | | | | | | | | | | |

Distress Comments (Items not covered above) ____________________

| Shoulders – Dominant Type | ✓ ONE | Distress | Severity Right Mod 1 | Severity Right Severe 2 | Severity Left Mod 1 | Severity Left Severe 2 | Density Right 10-30 1 | Density Right >30 2 | Density Left 10-30 1 | Density Left >30 2 |
|---|---|---|---|---|---|---|---|---|---|---|
| PAVED FULL | | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Break-up/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Break-up | | | | | | | | |
| GRAVEL | | | | | | | | | | |

(Density of Distress: Extent Of Occurrence, %)

| Maintenance Treatment | | Extent of Occurrence, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

Other Comments (e.g. subsections, additional contracts) ____________________

Evaluated by ____________________

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Figure 2/ The Pavement Condition Evaluation Form

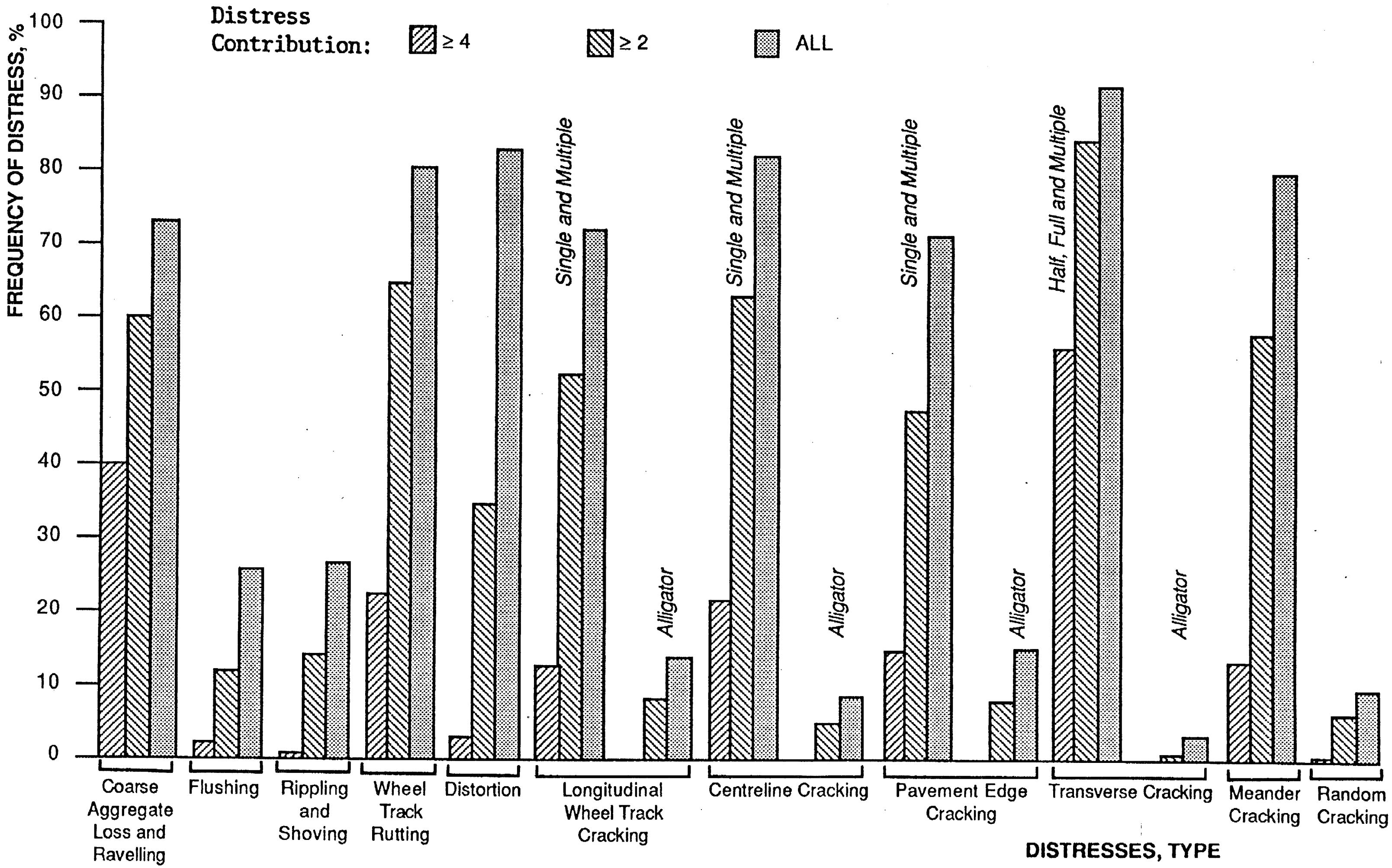


**Figure 3/ Occurrence of Distress Manifestations**

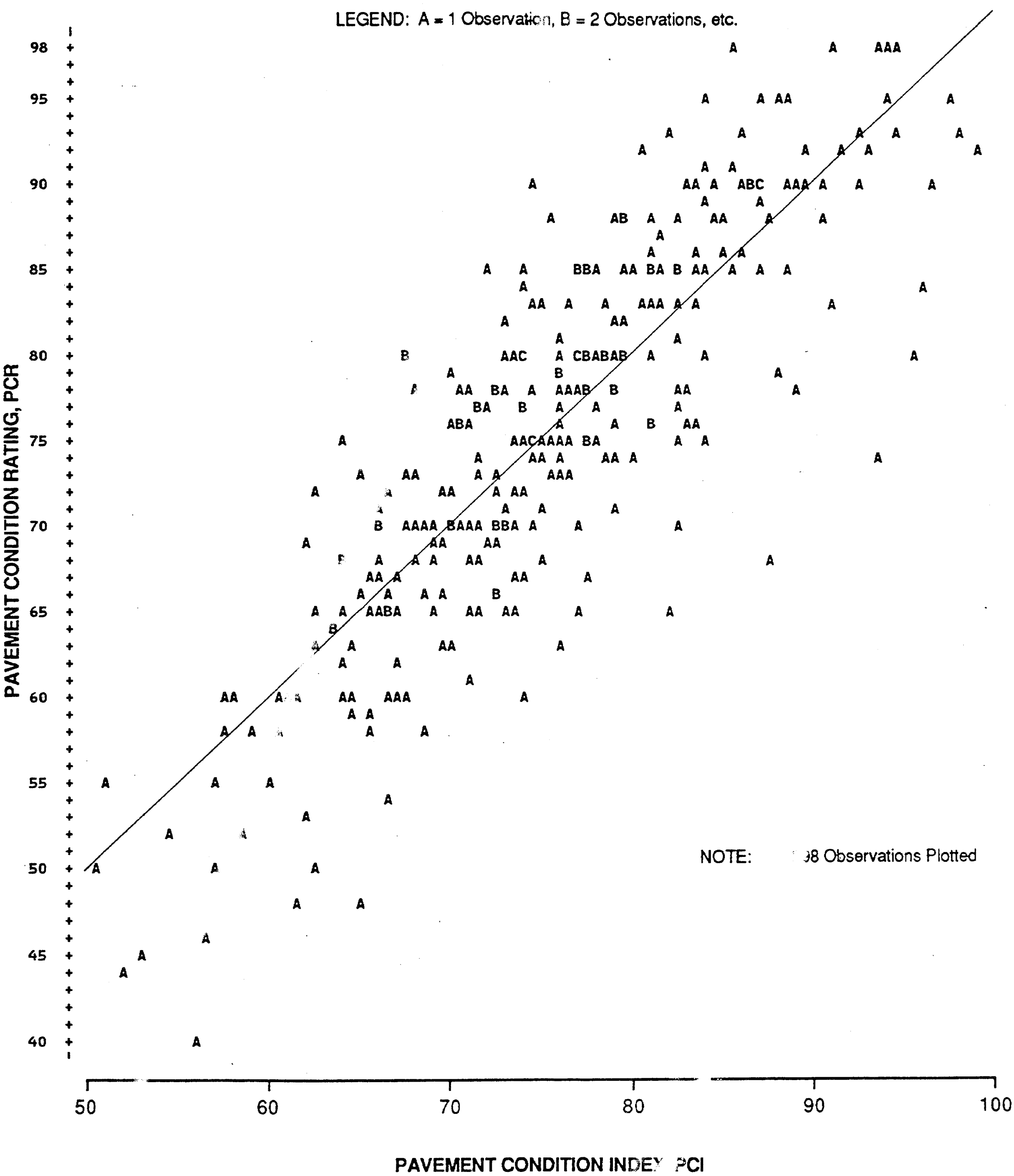


Figure 4/ Relationship Between PCR and PCI for Three Districts

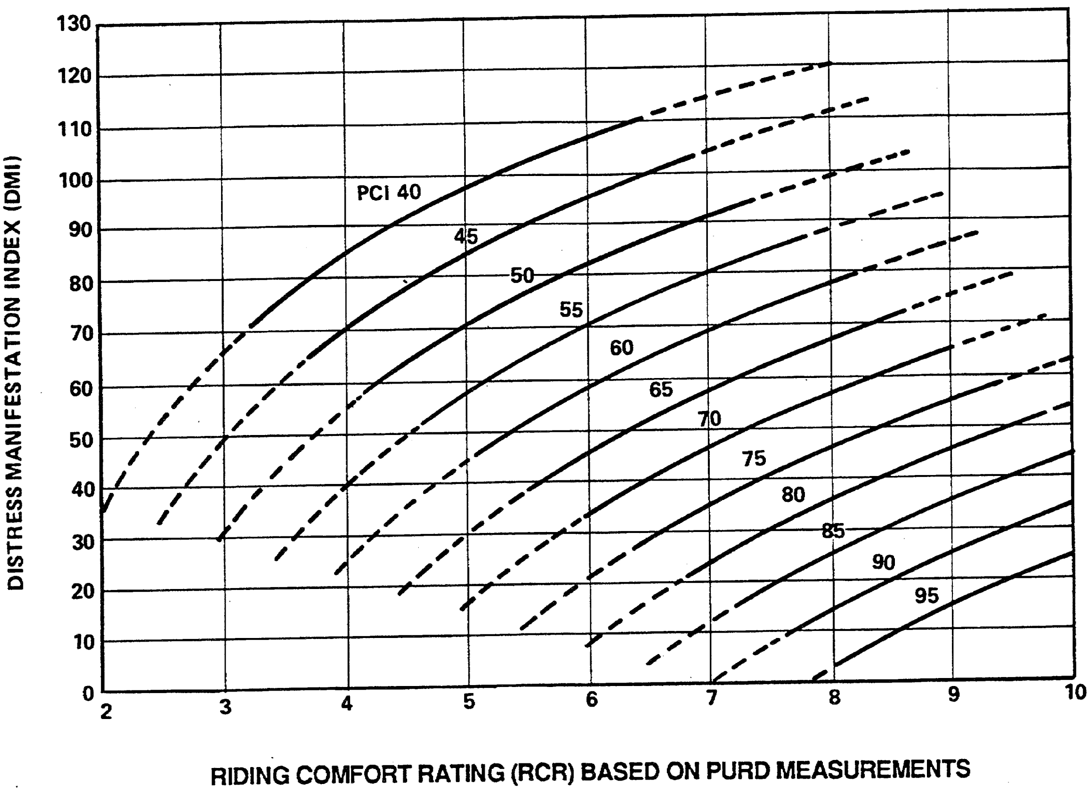


Figure 5/ Nomograph for PCI Calculation

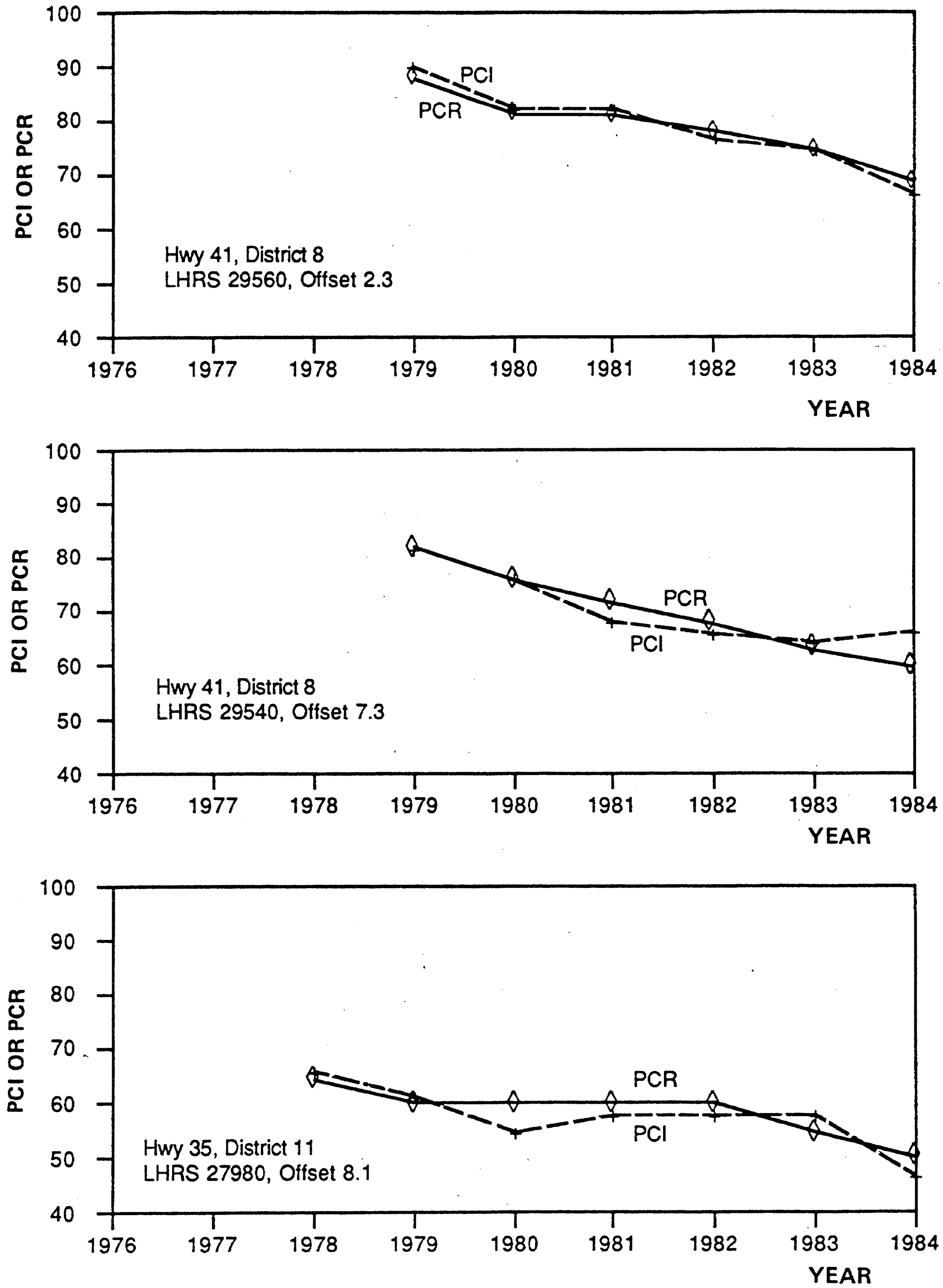


**Figure 6/ Comparison of PCI and PCR for Individual Sections**

# Appendix A

# A Guide for Completing the Flexible Pavement Condition Evaluation Form

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Research and Development Branch

**J.J. Hajek**
Project Research Engineer
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Ministry of Transportation and Communications
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# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

(1) Location From ______________________ To: ______________________

(2) LHRS [ ][ ][ ][ ][ ] BEGINS [ ][ ][•][ ] OFFSET km

(3) Section Length [ ][ ][•][ ] LENGTH km

(5) District [ ][ ]

(7) Survey Date [ ][ ] YEAR [ ][ ] MONTH

(8) PCR [ ][ ][ ]

(9) RCR [ ][•][ ]

(4) Traffic Direction [ ]
B : BOTH DIRECTIONS
N : NORTH BOUND
S : SOUTH BOUND
E : EAST BOUND
W : WEST BOUND

(6) Highway [ ][ ][ ][ ]

(10) Contract No. [ ][ ]—[ ][ ][ ]

(11) WP No. [ ][ ][ ][ ]—[ ][ ]—[ ][ ][ ]

(12) Facility [ ]
A : ALL LANES
C : COLLECTOR
E : EXPRESS
O : OTHERS (Additional Lanes)

(13) Class [ ]
F : FREEWAY
A : ARTERIAL
C : COLLECTOR
L : LOCAL
S : SECONDARY

**Riding Comfort Rating (At 80 km/h)**

- 10 EXCELLENT Smooth and Pleasant
- 8 GOOD Comfortable
- 6 FAIR Uncomfortable
- 4 POOR Very Rough and Bumpy
- 2 VERY POOR Dangerous at 80 km/h
- 0

| Pavement | | | Severity of Distress: Very Slight | Slight | Moderate | Severe | Very Severe | Density of Distress (Extent of Occurrence, %): Few | Intermittent | Frequent | Extensive | Throughout |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | <10 | 10-20 | 20-50 | 50-80 | 80-100 |
| | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | | | | | | | | | | |
| | Flushing | 2 | | | | | | | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | | | | | | | | | |
| | Wheel Track Rutting | 4 | | | | | | | | | | |
| | Distortion | 5 | | | | | | | | | | |
| CRACKING: Longitudinal Wheel Track | Single and Multiple | 6 | | | | | | | | | | |
| | Alligator | 7 | | | | | | | | | | |
| CRACKING: Centreline | Single and Multiple | 8 | | | | | | | | | | |
| | Alligator | 9 | | | | | | | | | | |
| CRACKING: Pavement Edge | Single and Multiple | 10 | | | | | | | | | | |
| | Alligator | 11 | | | | | | | | | | |
| CRACKING: Transverse | Half, Full and Multiple | 12 | | | | | | | | | | |
| | Alligator | 13 | | | | | | | | | | |
| CRACKING | Longitudinal Meander and Midlane | 14 | | | | | | | | | | |
| | Random | 15 | | | | | | | | | | |

| PARTIAL Shoulders: DOMINANT TYPE | ✓ ONE | DISTRESS | Severity of Distress: RIGHT Mod | RIGHT Severe | LEFT Mod | LEFT Severe | Density of Distress (Extent Of Occurrence, %): RIGHT 10-30 | RIGHT >30 | LEFT 10-30 | LEFT >30 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| PAVED FULL | | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Break-up/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Break-up | | | | | | | | |
| GRAVEL | | | | | | | | | | |

| Maintenance Treatment | | Extent of Occurrence, %: <10 | 10-20 | 20-50 | 50-80 | >80 |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ______________________

**Other Comments** (e.g. subsections, additional contracts) ______________________

Evaluated by ______________________

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Figure A1/ The Pavement Condition Evaluation Form (Annotated)

## A/ SECTION IDENTIFICATION

Figure A1 shows the numbered entries used for identification of the Pavement Management System (PMS) sections. There are 13 entries, as described below.

1. **Location** -- A written description of the beginning (**From**) and the ending (**To**) of the PMS section.

   The **From-To** direction must be in the direction of increasing Linear Highway Reference System (LHRS) numbers, i.e., from south to north and from east to west and, even on multi-lane highways, the direction is independent of traffic direction.

   The basic description that is already used and stated in the LHRS listing should be used whenever possible. If the LHRS listing shows several descriptions for one LHRS number, choose the description that is most easily recognizable in the field.

   An additional description, such as landmarks and buildings, may be added to the basic description. This information will also be stored by the computer and may help to locate the PMS section in the field.

2. **LHRS (Begins) and (Offset)** -- Linear Highway Reference System Number and Offset distance in kilometres for the beginning (**From**) of the PMS section.

3. **Section Length** -- The length of the PMS section in kilometres.

4. **Traffic Direction** -- The direction traffic moves on the PMS section. If the evaluation is for all lanes (e.g., a 2-lane highway), use the code B, meaning BOTH directions. On divided muli-lane highways (or, if required, on undivided multi-lane highways), record the appropriate traffic direction code.

5. **District** -- Number of the District in which the section is located. Enter the information 'right justified'. For example, District 9 would be entered as:

| | 9 |
|---|---|

6. **Highway** -- Enter the highway number and make it 'right justified'. For example, Highway 15 would be entered as:

| | | | |
|---|---|---|---|
| | | | 15 |

If the section has more than one highway number, for example, Hwy 35/115, use the lowest of the two numbers. However, if the section in question overlaps with a freeway, the freeway (400 series) number should be used. Highway numbers may also be entered alpha-numerically:

| | | | |
|---|---|---|---|
| | | 7 | A |

7. **Survey Date** -- The year and month in which the PMS section was evaluated.

8. **PCR** -- Pavement Condition Rating. Table A1 is a guide for estimating the PCR number on a scale from 0 to 100.

   Note that PCR may be discontinued in future and be replaced by Pavement Condition Index (PCI). (See also RCR.)

9. **RCR** -- Riding Comfort Rating. The RCR of the PMS section can be determined by driving over the pavement at 80 km/h and subjectively rating the ride using the scale given on the form.

10. **Contract Number** -- The last contract number. This requires a 5-digit number. If the PMS section covers more than one contract, the additional contract may be recorded under **Other Comments.** If the contract number is not available, leave it blank.

11. **W.P. Number** -- The Work Project Number should be entered if required and/or if available.

12. **Facility** -- This refers to the highway facility, for example, is the section on the collector lanes or the passing lane?

    Use this entry only with multi-lane highways when separate evaluation of a lane, or groups of lanes, in the same direction is required. Record the appropriate code as noted on the form.

13. **Class** -- Highway Class. Record the appropriate code as noted on the form. Refer to highway class as given in the Highway Inventory File.

## B/ PAVEMENT EVALUATION

Pavement distresses should be evaluated by driving very slowly, or walking, along the shoulder and checking off the appropriate pavement distresses. The completed Evaluation Form should reflect average conditions on the total length of the PMS section rated. This assumes that sections are selected to exhibit a uniform pavement performance.

**Note:** Pavement condition evaluation data are stored in a pavement management information data bank using a structured format. This format allows for entry and storage of only one severity and one density condition per distress (for any given section and survey year). For this reason, it is important to decide in the field which single severity condition and which single density condition best describes the average condition of the distress on the entire pavement section. Only these average conditions need to be recorded on the form and, at any rate, can be entered and stored in the data bank.

Detailed instructions, including pictures and descriptions of individual pavement distresses and their possible causes, are given in Reference 7, the report "Manual for Condition Rating of Flexible Pavements," SP-004. This report is available from the Editor, Research & Development Branch (416) 248-7226.

Since it was published, the instructions regarding severity of distresses in the above manual have been slightly modified and abbreviated as shown in Table A2.

The density of distresses is based on the percentage of the surface area of the pavement section affected by the distress, as noted directly on the Evaluation Form and summarized in Table A3. Note the new specific density description for transverse cracking given in Table A3.

Overall, it is important that distresses be classified and assessed as they appear on the pavement -- without subjective judgements. To avoid subjective judgements, the raters should frequently consult SP-004 and Tables A2 and A3 of the present guidelines.

Any unusual distress conditions, such as shape of wheel track rutting or unusual spacing of transverse cracks, should be recorded under **Distress Comments**.

## C/ SHOULDER EVALUATION

Shoulder Identification -- Check off the dominant type of shoulder in the PMS section. The dominant type is the shoulder next to the travelled portion of the pavement. The shoulder distresses for both left and right shoulders should be evaluated separately. "Left" and "right" shoulders are determined by the direction of the increasing LHRS numbers.

On a highway running from south to north, the shoulder on the east side of the pavement is always "right", and the shoulder on the west side is always "left".

On a highway running from east to west, the shoulder on the north side of the pavement is always "right", and the shoulder on the south side is always "left".

### Description of Shoulder Distresses

**a) Fully and Partially Paved Shoulders**

**Cracking** -- Includes all types of cracks (such as longitudinal, transverse, and alligator cracks) with the exception of construction (longitudinal) joint between a pavement and the shoulder, or those between the shoulder and a curb.

**Pavement Edge and/or Curb Separation** -- These are longitudinal construction joint cracks separating a pavement and shoulder or a shoulder and a curb.

**Distortion** -- Includes heaving, depressions, curling of edges and other distortions.

**b) Surface Treated and Primed Shoulders**

**Break-up/Separation** -- Progressive cracking which results in potholing and loss of material.

**Edge Break** -- Progressive outermost edge cracks which result in loss of material.

## Evaluation of Severity and Density of Shoulder Distresses

The severity of shoulder distresses should be evaluated by driving very slowly, or walking, along the shoulder and recording the distresses observed. The rating of severity should be based on the guidelines given in Table A4.

The density of distress is based on the percentage of the surface area affected within the PMS section. The range in percent is shown directly on the form.

## MAINTENANCE TREATMENT EVALUATION

### Description of Maintenance Treatments

**Manual Patching** -- Repairs are carried out using hand tools and are likely to cover small areas such as potholes. Includes both hot- and cold-mix materials.

**Machine Patching** -- Repairs are carried out by using a spreader or grader, and are likely to cover half the width or the full width of lane. Includes both hot- and cold-mix materials.

**Spray Patching** -- Asphalt emulsion is sprayed with a wand and covered with sand and stone chips applied by shovel.

**Rout & Seal Cracks** -- Sealed cracks, particularly those which have been routed and cleaned before sealant was applied.

Note that the crack where the sealant has failed and is thus no longer effective should not be included. Such cracks should be recorded as existing pavement distresses as described in Section B of this appendix.

**Chip Seal** -- Asphalt emulsion applied by spray bar and covered with sand and stone chips applied by a spreader or spreader box, and then rolled.

**Extent of Occurrence**

**Pavement** -- Estimate as a percentage of the PMS section length on which the maintenance treatment(s) has been carried out.

**Shoulder** -- Estimate as a percentage of the total shoulder area within a PMS section (right and left shoulders combined) on which the maintenance treatment(s) has been carried out.

## COMMENTS

**Distress Comments** -- The space provided can be used to describe pavement distresses and their characteristics, which are considered to be important but cannot be described using the check off portion of the form. For example, the pattern and spacing of transverse cracks, or the presence of frost heaves.

**Other Comments** -- Put down all other comments considered to be important for a comprehensive evaluation of the roadway.

**Table A1/ A Guide for the Estimation of Pavement Condition Rating for Flexible Pavements**

| | |
|---|---|
| 0 - 20 | Pavement is in poor to very poor condition with extensive severe cracking, alligatoring and dishing.<br><br>Rideability is poor and the surface is very rough and uneven. |
| 20 - 30 | Pavement is in poor condition with moderate alligatoring and extensive severe cracking and dishing.<br><br>Rideability is poor and the surface is very rough and uneven. |
| 30 - 40 | Pavement is in poor to fair condition with frequent moderate alligatoring and extensive moderate cracking and dishing.<br><br>Rideability is poor to fair and surface is moderately rough and uneven. |
| 40 - 50 | Pavement is in poor to fair condition with frequent moderate cracking and dishing and intermittent moderate alligatoring.<br><br>Rideability is poor to fair and surface is moderately rough and uneven. |
| 50 - 65 | Pavement is in fair condition with intermittent moderate and frequent slight cracking, and with intermittent slight or moderate alligatoring and dishing.<br><br>Rideability is fair and surface is slightly rough and uneven. |
| 65 - 75 | Pavement is in fairly good condition with slight cracking, slight or very slight dishing and a few areas of slight alligatoring.<br><br>Rideability is fairly good with intermittent rough and uneven sections. |
| 75 - 90 | Pavement is in good condition with frequent very slight or slight cracking.<br><br>Rideability is good with a few slightly rough and uneven sections. |
| 90 - 100 | Pavement is in excellent condition with few cracks.<br><br>Rideability is excellent with few areas of slight distortion. |

*Note: This table is based on Table B-1 in MTC report SP-004 (Reference 7).*

**Table A2/ Guide for Describing Severity of Pavement Distresses**

| Severity of Distress | 1 Ravelling and Coarse Aggregate Loss | 2 Flushing | 3 Rippling and Shoving | 4 Wheel Track Rutting | 5 Distortion | Single & Multiple Cracks: 6. Longitudinal Wheel Track 8. Centreline 14. Meander and Midlane 15. Random | Single & Multiple Cracks: 12. Transverse | Alligator Cracking: 7. Longitudinal Wheel Track 9. Centreline 13. Transverse | 10-11 Pavement Edge Cracking |
|---|---|---|---|---|---|---|---|---|---|
| 1 Very Slight | Barely Noticeable | Very faint colouring | Barely noticeable | Barely noticeable (< 6 mm) | Noticeable swaying motion | Crack width < 2 mm<br>Hairline | Crack width < 2 mm<br>Full and partial cracks | Alligator pattern forming<br>Depression < 12 mm | Single longitudinal or single wave-formation |
| 2 Slight | Noticeable | Colouring visible | Noticeable | 6 to 12 mm | Good control of car still present | 2 to 12 mm width<br>Single cracks | 2 to 12 mm width<br>Single full-width cracks | Alligator pattern established with corners fracturing<br>Depression > 12 mm | Multiple parallel longitudinal or wave-formation less than 0.5 m from pavement edge |
| 3 Moderate | Pock-marks well-spaced, open texture | Distinctive appearance with free asphalt | Rough ride<br>Washboard appearance | 12 to 19 mm<br>Multiple cracks may be starting | Fair control of car | 12 to 19 mm width<br>Multiple cracks starting | 12 to 19 mm width<br>Single full cracks with slight cupping or lipping or multiple cracks starting | Alligator pattern established with spalling of blocks<br>Depression > 19 mm | Progressive multiple cracks extend over 0.5 m but less than 1 m from edge. Crack begins to braid. |
| 4 Severe | Pock [illegible] closely-spac[illegible] disintegration, small pot holes | [illegible] asphalt [illegible] [illegible] look | Very rough ride<br>[illegible] [illegible]ounced [illegible] app[illegible] | 19 to 25 mm<br>May include multiple longi-[illegible]dinal cracks | Poor control of car | 19 to 25 mm width<br>Multiple cracks, spalling begins to develop | 19 to 25 mm width<br>Single full cracks with moderate cupping or lipping, or multiple cracks | Blocks begin to lift, patching required.<br>Depression > 25 mm | Progressive multiple cracks extend over 1.0 m but less than 1.5 m from edge.<br>Begins to alligator. |
| 5 Very Severe | Disintegrated with large pot holes | Wet look with tire noise like wet pavement surface | May cause loss of control of vehicle | Rutting [illegible] mm<br>May include multiple longi-tudinal cracks | [illegible]tinuous [illegible]tortion, may [illegible] [illegible]rous at speeds [illegible] km/h | Width > 25 mm<br>[illegible]ltiple cracks with spall[illegible] developed. [illegible] begin [illegible] alligator. | Width > 25 mm<br>Severe cupping or lipping, multiple cracks with spalling. May begin to alligator. | Complete disintegration of affected area, pot holes from missing block.<br>Depression > 50 mm | Progressive multiple cracks extend over 1.5 m from edge.<br>Outermost area near edge is alligatored. |

*Note: - Crack width should be determined during the period from May to October.*
*Do not report routed and sealed cracks, these will be reported as Maintenance Treatment.*

Table A3/ Guide for Describing Density of Pavement Distresses

| Class or Code | Description | For all Distresses Except Transverse Cracking* | For Transverse Cracking Only |
|---|---|---|---|
| 1 | Few | < 10% | Cracks (full and/or half cracks) are more than about:<br>40 m apart |
| 2 | Intermittent | 10 - 20% | No set pattern. Cracks (full and/or half) are about:<br>30 to 40 m apart |
| 3 | Frequent | 20 - 50% | A set pattern. Cracks (full and/or half) are about:<br>20 to 30 m apart |
| 4 | Extensive | 50 - 80% | Rather regular pattern. Cracks (full and/or half) are about:<br>10 to 20 m apart |
| 5 | Throughout | 80 - 100% | Regular pattern. Cracks (full and/or half) are less than about:<br>10 m apart |

*Based on percent of surface area within the PMS section affected by distress.*

Table A4/ Guide for Describing Severity of Shoulder Distresses

| Severity of Distress / Type of Distress | 1. Moderate | 2. Severe |
|---|---|---|
| **Cracking** | Progressive multiple cracks begin to develop | Progressive multiple and alligator cracking |
| **Pavement Edge and/or Curb Separation** | Single cracks, width:<br>12 to 19 mm | Single or multiple cracks width:<br>> 19 mm |
| **Distortion** | Noticeable edge curling, depression, heaving.<br>No major cracks | Obvious edge curling, depression, heaving,<br>with multiple cracks |
| **Break-up/ Separation** | Disintegration with small potholes up to 150 mm | Disintegration with potholes > 150 mm |
| **Edge Break** | Edge cracked with some loss of material | Edge breaking with extensive loss of material |

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