1- PAVEMENT CONDITION SURVEYS

Pavement Condition Surveys refer to activities performed to give an indication of the serviceability and physical conditions of road pavements. These activities have three main aspects namely data collection, condition rating and quality management.

The level of repair and rehabilitation done on the roads depends on the physical condition of the road at a particular time in relation to its acceptable and operable condition. Thus, the condition of pavements is monitored regularly and this is known as pavement condition monitoring. These condition monitoring surveys play a vital role in pavement management since it provides valuable information that forms the basis of repair and rehabilitation activities.

2- IMPORTANCE OF CONDITION RATING SURVEYS

- First, pavement condition monitoring helps agencies to schedule maintenance and rehabilitation works efficiently
- Second, pavement condition ratings are used as a fair basis of comparison for different pavements. In other words, pavement condition ratings allows for a more objective comparison of two or more pavement sections.
- Third, condition ratings enable DOTs and all stakeholders to estimate the level of repair and rehabilitation required in terms of costs and extent of deterioration. This is because the condition ratings reflect the current condition of the pavement.
- Lastly, data obtained from condition surveys can be used for long-term budget planning. The survey data of past and present conditions can be used to project future conditions and this serves as a guide for management during allocation of funds for future works.

3- DATA COLLECTION

3-1 Data Collection Types

Data collection is a very important part of the condition survey process. The type of data that is collected by DOTs varies nationwide. This is because different DOTs consider different factors as indicators of pavement performance and deterioration. Examples of data collected during surveys are rut depth, International Roughness Index (IRI), faulting, among others. Data that is collected during condition surveys depend on the type of pavement, whether rigid or flexible. The **types of data** collected can be categorized into four groups. They are distress data, structural capacity, ride quality data and skid resistance data.

Ride quality data refers to IRI, profile data and Present Serviceability Rating (PSR) data. It is data that gives an indication of how comfortable it is to ride along a particular section. Ride quality data is sometimes referred to as roughness data. This type of data is associated with the quality of the ride as experienced by road users. The ride quality is quantified using the IRI or PSR.

Distress data also refers to the data that describes the types, extent and severities of distresses on the pavement surface. This type of data is usually in the form of pavement images and videos which are analyzed by trained engineers who identify the distresses present. Similarly, the data can also be collected through visual inspections during condition surveys. Pavement

distresses are major signs of deterioration and usually manifest as distortions, disintegrations and fractures. Distortions refer to corrugations and rutting. Disintegrations also refer to spalling, stripping and raveling.

Structural Capacity data gives an indication of the load carrying capacity of the pavement. This type of data collection is usually conducted at the project level using destructive and non- destructive methods. Deflection measurements are typically used to calculate the load transfer capabilities of the structural layers and hence, the structural capacity of the pavement.

Skid resistance data refers to the force developed when a wheel slides along a pavement surface when it is prevented from rotating. It is dependent on the microtexture and macrotexture of pavements. There must be some level of skid resistance in order to prevent skidding accidents. Skid resistance decreases over time as the aggregates used in the pavement construction become polished. Skid resistance varies seasonally and so this must also be taken into consideration during measurement.

3-2 Data Collection Methods

There are two approaches to collecting pavement data. They are automated and manual pavement data collection methods. The manual methods have unique characteristics that make DOTs continue to rely on them. The characteristics of both approaches are tabulated in table (1). The two methods are compared in terms of time, safety of staff, objectivity of measurements, cost, data size, handling and employers' point of view.

Table 1: Comparison of Automated and Manual Pavement Data Collection Methods

	Automated Data Collection	Manual Data Collection
Time	Reduces data collection times	Longer data collection times
Safety	Much safer means of collecting data	Personnel at risk collecting data
Objectivity	Objective measurements	Usually subjective since it depends on experience of personnel
Cost	Very expensive equipment costs	Relatively less expensive
Data Size	Vast amounts of data collected & stored depending on capacity of equipment	Agencies may only be able to collect smaller amounts of data at a time
Data Handling	Not subject to transcription errors	Subject to transcription errors
Employers	Suitable in agencies seeking to downsize number of employees	Source of employment for rating staff
Coverage	May cover footprint of data collection vehicle. Multiple runs sometimes needed to cover entire road width	Inspectors can cover entire width of road section relatively easier

The manual walking survey procedure mentioned earlier is one method of data collection which has been used for many years. It is done on selected inspection units in the management section. The manual distress surveys are slow, labor-intensive and subject to

errors. Consistency between classification and quantification of the distresses observed by the raters can also be a major problem.

Automated methods are used to minimize the errors and standardize the survey process, agencies employ automated methods in recording, reduction, processing and storage of pavement data. An automated distress survey can be defined as any method in which distress data is entered directly to the computer in the field during the survey. This type of survey can reduce greatly errors associated with transferring data from paper forms used in the field to computer systems for analysis. Other benefits of automated distress surveys include safety for survey crews, faster and more objective surveys. Most states now use automated means to collect data on pavement friction, roughness, profile, rut depth and deflection.

3-3 Data Collection Equipment

4- Condition Rating Systems

The condition rating of a pavement section refers to a score that quantifies the performance. This rating is based on measures such as roughness, skid resistance, deflection among others obtained during the data collection process. The condition ratings are used as a basis for comparing the performance of two road sections. Most importantly, they help agencies to determine the extent and severity of pavement defects and estimate the cost of repair and rehabilitation and prioritize treatment procedures. They are also used as a basis for planning budgets. Condition rating indexes have also in a way reduced the political pressure that formed a greater part of the decision making process.

4-1 Classes of Condition Indexes

Different States across the country use different approaches towards pavement condition rating. The condition rating systems can be grouped into two main groups namely estimated condition ratings and measured condition ratings. The estimated condition rating systems are based on observed physical conditions of the pavements while the measured condition rating systems are not only based on observations by trained raters but are also backed by physical measurements such as roughness and mathematical expressions. Most of the state agencies use the measured rating systems since they provide a more objective rating of the performance of the pavements. See figure (1) for examples of rating systems in the two categories.

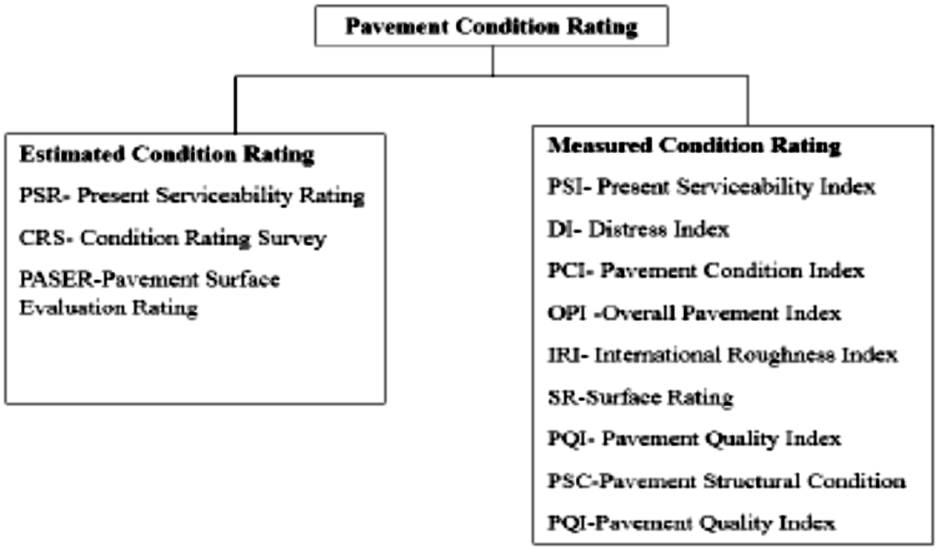

Figure (1) Pavement Condition Rating Systems

4-1-1 Estimated Condition Survey

Present Serviceability Rating (PSR)

The most common and fundamental pavement condition rating index is Present Serviceability Rating (PSR). This is from AASHO and is based on the ride quality as experienced by a panel of observers riding in a vehicle on a particular section of pavement. The rating scale used is from 0 to 5 as shown below in figure (2). The mean of the individual ratings is the present serviceability rating.

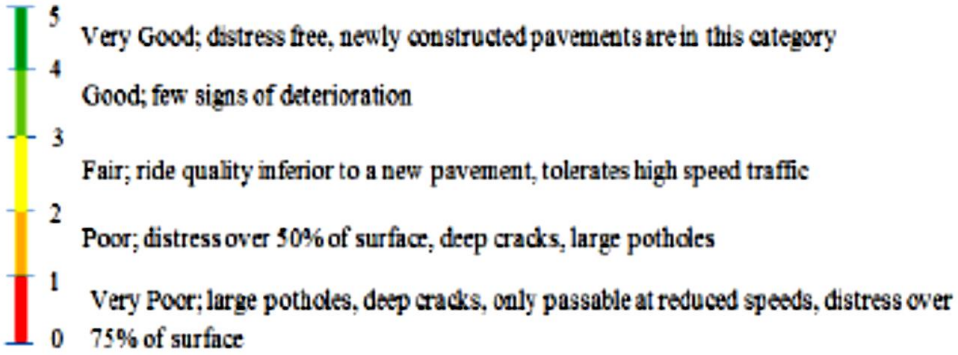

Figure 2: Present Serviceability Rating

Condition Rating Survey (CRS)

The Condition Rating Survey (CRS) is also another estimated condition rating system used by the Illinois Department of Transportation (IDOT). The scale is a 1.0-9.0 scale with increments of 0.1. A value of 1.0 represents total failure while a value of 9.0 represents a newly constructed pavement. The values are assigned based on a CRS Manual developed in 2004. The manual has several images that guide the inspector in assigning appropriate values. CRS

has evolved over the years into a measured condition rating at the state level since algorithms have been developed to incorporate the measured defects into the calculation of condition rating values. Some agencies at the local level still use the original form of the CRS.

Pavement Surface Evaluation and Rating System (PASER)

Another estimated rating system is the Pavement Surface Evaluation and Rating System (PASER). It comes under the estimated rating systems since it is also a visual rating of the pavement conditions based on a 1-10 scale. Similar to the CRS, there is a manual with photographs and descriptions that guides inspectors to choose the appropriate value on the scale that captures the conditions accurately.

4-1-2 Measured Condition Rating

Present Serviceability Index (PSI)

For the measured condition ratings, the Present Serviceability Index (PSI), a 0-5 index is considered as a measured rating system since it is based on physical measurements of pavement characteristics in addition to observations from trained raters. The information from the panel of raters who rated roads in Illinois, Minnesota and Indiana was correlated with the roughness, rut depth, cracking and patching measurements of the pavement to produce this index. This test and analyses were carried out by AASHO (American Association of State Highway Officials) between 1958 and 1960 with the aim of providing a much more objective means of establishing pavement conditions.

$$PSI = 5.03 - \log(1 + SV) - 1.38(RD)^2 - 0.01(C + P)^{1/2}$$

where PSI= Present Serviceability Index

SV=slope variance of section obtained using CHLOE Profilometer

RD= mean rut depth (in)

C=cracking (ft/1000 sq. ft)

P=Patching (sq. ft/1000 sq. ft)

For Rigid Pavement

$$\text{PSI} = 5.41 - 1.8\log(1 + S_v) - 0.09\sqrt{(C_l + P_a)}$$

where:

S_v = slope variance [$\log(1 + S_v)$ = function of profile roughness]:
C_l = crack length in inch (1 in. = 25.4 mm).
P_a = patching area in ft^2.

$$SV = \frac{\sum_{i=1}^{n} Y_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} Y_i\right)^2}{n-1} \qquad (19.12)$$

where:

SV = Slope Variance.
Y_i = difference in elevation between two successive points at a constant distance of 1 ft (305 mm).
n = number of intervals.

Pavement Condition Index (PCI)

The Pavement Condition Index is also a measured condition rating system developed by the US Army Corps of Engineers and adopted by the American Public Works Association and American Society for Testing and Materials (ASTM). It is based on a 0-100 scale. See figure (3) for an illustration.

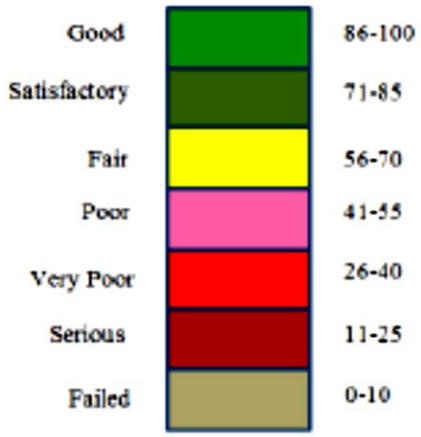

Figure 3: PCI Ratings (Illinois Center for Transportation, Implementing Pavement Management Systems for Local Agencies-State-of-the-Art/ State-of-the-Practice)

Overall Pavement Index (OPI)

Some agencies also use the Overall Pavement Index which is based on the Modified Distress Rating (*MDR*). The MDR is also based on the PSI which in turn is derived from the *IRI*. The following equations will further explain the OPI.

$$PSI = 5e^{0.198-0.000261(IRI)}$$

$$MDR = 20(PSI)$$

$$OPI = MDR(PSR/5)^{0.22}$$

5- Quality Management

Many transportation agencies are developing procedures and guidelines for managing the quality of pavement data collection activities to ensure that the data collected meets the needs of the pavement management process. Pavement data quality is receiving increased attention due to fact that the data quality has a critical effect on the pavement management decisions.

The most efficient way to achieve high-quality pavement condition data collection is to adopt a comprehensive and systematic quality management approach that includes methods, techniques, tools and model problem solutions. Quality management involves the specification of data collection protocols, quality standards, responsibilities of personnel, quality control, quality acceptance, corrective action and quality management documentation.