Pavement Condition Index (PCI) for the Maintenance of City Roads- A Review

Sabira Javaid[1], Er. A.K Duggal[2]

[1]M.E Scholar, Civil Engineering Department, NITTTR, Chandigarh
[2]Associate Professor, Civil Engineering Department, NITTTR, Chandigarh

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ABSTRACT: *This study is a survey to evaluate flexible pavement distress and to determine the type of failure and its level of severity by assessing pavement performance using the Pavement Condition Index (PCI). This is a fundamental component of pavement management that will allow us to choose the correct methods of treatment and maintenance. The PCI is a numerical index commonly used for pavement condition assessment and pavement structural reliability. It is a new tool that has been embraced worldwide. Its rating value varies from 0 to 100, with the worst possible condition being 0 and the best possible condition being 100. For this study, the Chandigarh city roads are selected for evaluation and inspection purposes. Most of the damages and failures were caused by disintegration like loss of aggregate, potholes, stripping etc. After identifying distress, type and severity level by different measurements these need to be assigned acceptability levels and weightage rating factors for different severity levels. The final rating value is determined by taking all the parameters as an average of the weighted rating value. We can assess the condition of the road using this rating value and can determine maintenance steps and frequency in order to make it cost-effective. Since nature of traffic in a city is distinctively different from a NH or SH, the parameters in formulation of PCI need a re-thinking.*

Keywords: Pavement Condition Index (PCI), Weightage rating value, flexible pavement.

1. INTRODUCTION: City roads are a major asset to the country's infrastructure development. These roads are the busiest roads in the country. These roads have special importance for individuals as these connect residential area to commercial areas and other major parts of the city. It is therefore very important to take care of these roads. In a modern city like Chandigarh, although these roads may be designed and constructed appropriately, still these require periodic repairs. Most of the roads are black top except where the water logging necessitated concrete roads. Providing an overlay of bituminous type depending category of road and many factors is a common practice in Chandigarh as well in almost all the cities. However, it may not be feasible to restore the original state of the flexible pavement every time by an overlay, but other corrective measures may also be required based on existing condition.

Road maintenance requires a number of activities, i.e. identification, preparation, programming and scheduling of defects for actual field implementation. Maintaining the road surface in good condition and maximizing the life of the road is the key task of maintenance. Due to increase travel demand from the general public, the effect of roads on economic growth and the need to drive at higher speeds due to technological advancements, road maintenance has gained more significance in recent years. Its significance of maintaining highways in good condition emanates from one or more of the following reasons:

a) Reduction in vehicle operation cost (VOC).

b) Reduction in rate of accidents.

c) Keeping roads traffic worthy in all weathers.

d) Reduction in pollution due to reduced fuel consumption on well maintained pavement surface.

e) It also saves budgetary expenditure of restoration or reconstruction.

f) Reduction in rate of deterioration and improvement in life of road.

1.1 The various processes in maintenance of highways:

- Identify and evaluate the circumstances (structural and aesthetic).
- Defining and pricing alternate behavior and associated implications.
- Obtain the necessary approvals and financing.
- Develop a work program including the scale of periodic work needed and the frequency of intervention.

1.2 Types of maintenance:

Maintenance is broadly divided into three categories**:**

- Routine maintenance
- Preventive maintenance
- Periodic maintenance
- Special maintenance

1.3 TYPES OF DEFECTS OCCUR IN FLEXIBLE PAVEMENTS:

The types of defects in flexible pavements:

- *Surface defects*: These include fatty surface, hungry surface and smooth surface.

- *Cracks*: These include all types of cracks, like alligator cracks, hairline cracks, longitudinal cracks, reflection cracks and edge cracks.
- *Deformation*: These include corrugations, rutting, shoving, shallow depressions, settlements and upheavals etc.
- *Disintegration*: these include loss of aggregates, stripping, raveling, potholes and edge breaking.

1.4 EVALUATION OF PAVEMENT CONDITION INDEX (PCI)

Pavement Condition Index (PCI) of a pavement section should be determined on the basis of data gathered during the pavement condition survey. Actual measurements will be used to determine the PCI of the road sections/roads listed and then include the ratings for each parameter and various weighting factors. Appropriate weightage (multiplier) for the rating value of each parameter is given after assigning the rating number to each parameter to calculate the weighted rating value of each individual parameter. An average of the weighted rating values of all parameters will be used to determine the final rating value.

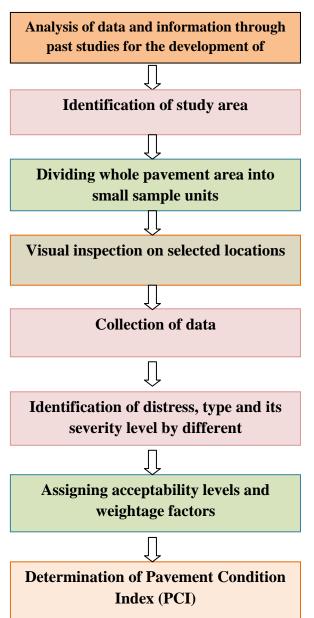## 2. NEED AND SCOPE OF THE STUDY

Chandigarh, the city beautiful is having nearly 1550 km of road length under the jurisdiction of Municipal Corporation. A general practice of providing an overlay at a pre-determined periodic interval is commonly adopted. The thickness of overlay which generally is 30 mm to 40 mm is based on road category. However a regular practice of periodic overlay results in raising the road levels that result in functional problems. At times, a simple overlay does not provide the complete solution. Hence a comprehensive evaluation of pavement deterioration is needed that can be fulfilled by application of PCI The study will focus on the development of (PCI) Pavement Condition Index for the flexible pavements which will help in the pavement maintenance so as to minimize the cost of maintenance and enhance the life of road. This shall also help in development of (PMMS) Pavement Maintenance Management System for Chandigarh roads for the scientific planning of maintenance techniques and judicious allocation of maintenance funds.

3. OBJECTIVES:

The main objectives of work are:

1. To make a preliminary condition survey of roads of different categories like V-4, V-5 and V-6 and detailed condition survey of V-6 roads.
2. To identify various types of defects and prepare a list in hierarchy of their occurrence.
3. To develop a systematic approach to ascertain distress and its severity.
4. To ascertain pavement rating or pavement condition index (PCI) for V-6 roads of Chandigarh city.

4. RESEARCH METHODOLOGY:

5. LITERATURE REVIEW

Haas Ralph et al. (2009) [1] the authors evaluated performance indicators for roads in Canada. In the use of performance indicators, the author explains more precisely the role of performance indicators in modern road asset management and identifies the fundamental goal of pavement indicators, the importance of stakeholder participation and the need to achieve a balance between productivity and transport values. The structure for indicators was further established, and foreign and Canadian examples were also presented. A mechanism for connecting policy priorities with performance metrics was proposed in the report. The findings suggested that a holistic approach to the production of performance metrics should take into account the basic rationale, the balance between their usage

and reporting, the efficiency and reliability of the measurement used critically, and the stakeholders involved in pavement development.

Ryntathlang L. Teiborlang (2011) [2] evaluated Pavement Condition Index (PCI) for rural roads in Assam. The new instrument used worldwide is the Pavement Condition Index (PCI). It is a numerical ranking for the state of the pavement ranging from 0 to 100, 0 being the worst possible condition and 100 the best possible condition. The author identified the methodology used to carry out the pavement survey and to test the pavement with case studies of four rural Assam roads. In conclusion, this method removes the need to use pavement condition score, age factor score and traffic volume score in the methodological approach of rating the conditions of a pavement by this method.

Shah U. Yogesh et al. (2013) [3] A study was conducted to assess the performance of urban road network pavement by using different indicators of pavement condition such as the Pavement Condition Index (PCI), Present Serviceability Rating (PSR), Roughness Index (RI) etc. First of all, efforts were made to establish and design the Combined Overall Pavement Condition Index (OPCI) for some selected roads in Noida. It has been concluded that the overall performance of the pavement depends on the average value of all parameters. Index of pavement condition, roughness index, pain index of pavement condition, structural capability index of pavement condition and skid resistance index of pavement condition. Furthermore, the use of multi-indices condition indicators was suggested to be more useful in selecting suitable treatment to completely restore the riding standard and structural integrity of the pavements.

Adlinge S. Sharad et al. (2013) [4] In terms of reducing serviceability caused mainly by the creation of cracks and ruts, pavement failure was identified. The author described modules on the number of projects in India learned from pavement failures and issues encountered in recent years. Different pavement maintenance strategies and initiatives that will help enhance the serviceable life of the pavements have been addressed on the basis of previous experience It was concluded that a major cause of cracking is the rapid increase in traffic loading, especially on new roads where the design is focused on lower traffic, the provision of weak shoulders leads to edge failure and poor sub-grade corrugation effects on the surface. Bad drainage was also considered as the key issue causing the maximum pavement surface failure.

Katkar R. S et al. (2014) [5] investigated the ultimate aim of the Maintenance Management System (MMS) is to maximize the resources needed to update this utility. 70 pavements were studied and the relationship between the quality of the pavement and the corresponding cost of maintenance was given. The results of the research include a clear and practical technique for categorizing the condition of the pavement in terms of repair cost. They developed a

value for pavement quantification on a scale of 7-1, 7 being the new pavement condition, and 1 being the poor condition.

Boyapati Bhavath et al. (2015) [6] suggested how by data collection, to evaluate the Pavement Condition Index (PCI) and also analyze it to primarily prioritize pavement maintenance. Various distress data such as cracks, patches, potholes, and ruts were gathered based on the level of distress for the report. Weighting variables were often allocated to the various forms of distress. The Pavement Condition Index (PCI) values were determined by the author from the deduction values (DV) and from the correlated deduction value (CDV) graphs. The analysis of traffic volume and data on riding quality were also considered. Thanjavur (TM) pavements were found to have pavement condition index (PCI) values ranging from 45-60 in which 25% of cracks, 20% of patches, and 15% of potholes were found on both sections. It was concluded that the degree and quantity of cracking and patching values play a vital role in the pavement condition index (PCI) does not require any priority-based maintenance operation and pavements with lower pavement condition index requires maintenance on priority

Zumrawi M.E. Magdi (2015) [7] The analysis of traffic volume and data on riding quality were also considered. Thanjavur (TM) pavements were found to have pavement condition index (PCI) values ranging from 45-60 in which 25% of cracks, 20% of patches, and 15% of potholes were found on both sections. It was concluded that the degree and quantity of cracking and patching values play a vital role in the pavement condition index (PCI) does not require any priority-based maintenance operation and pavements with lower pavement condition index requires maintenance on priority**.** It was concluded that the emphasis should be on developing guidelines that are versatile enough for use in a variety of circumstances that are systematic, straightforward and easy to comprehend.

Andrei Radu et al. (2015) [8] using basic pavement condition metrics, assessed the efficiency of flexible pavements. The pavement serviceability index (PSI), pavement condition index (PCI), skid resistance (SR) and pavement damage were different parameters used in the analysis (consumed life). The PSI was assessed using the AASHTO road test. That ranges from 0-5.0 being the worst pavement condition and the best condition being 5**.** The entire pavement is first divided into small sample units for the pavement condition index (PCI) and determined by deduct values and correlated correction curves, SR by the skid resistance tester and pavement damage is a measure of the percentage of life absorbed at any given moment during the pavement's service life. Some ratings for these versatile pavements and suitable treatments were provided after operating on all these parameters.

Karim M. A. Fareed et al. (2016) [9] examined the state of surface of roads, recognize repair and rehabilitation needs in Yemen. By using PAVER software (1982) condition rating

procedure as defined in technical manual TM 5-623, the author assessed pavement condition in terms of surface distress. First, they inspect the sample device, identify the type of distress, the degree of intensity, and then calculate the density. Then the deduct value curves were used for each form of distress and the pavement condition index was calculated using the PCI = 100-CDV relation, where the deduct value is associated with CDV. The author proposed maintenance for the pavement parts on the basis of determined ranking is the continuation of the current maintenance policy.

Zafar S. Muhammad et al. (2019) [10] worked to preserve and rehabilitate pavements for the serviceability necessary. The assessment of the present state of a pavement network and anticipation of potential conditions is a critical element of the pavement management system (PMS). The Lakhi larkana national highway was chosen for the analysis and the Pavement Condition Index (PCI) was calculated. By gathering all the distress data, the first author gathered all the information of the road situation. After this pavement condition index (PCI) evaluation is performed in 3 stages, the pavement network was first established, then the pavement distress measure was performed, and the pavement condition index (PCI) is further calculated by correlated deduct value (CDV) graphs. The key cause of distress was concluded to be heavy traffic axle load and water logged field. Occurrence of the state of pavement consideration in critical pavement condition index (PCI) range warrants for its timely rehabilitation.

6. EXPECTED OUTCOME:

The outcome which is expected from the proposed work is that the parameters to determine pavement condition index (PCI) shall be identified and provided a rating which will help in rating pavement on the basis of their type, extent severity of degradation and helps in selecting the effective maintenance policy at the right time on the basis of priorities. This will further lead to optimize the expenditure on pavement maintenance.

7. CONCLUSION:

The degradation of the pavement is a severe road problem. The authorities, engineers and policy makers concerned should develop a systematic approach towards the thorough evaluation of roads. When the roads are still in " fair to good" condition they must be selected for maintenance, and before the need in order to prevent their rapid degradation after a certain limit and to avoid continuous periodic survey of road conditions, the cracks should be filled at the beginning of their occurrence and the drainage system should be checked regularly. In selecting appropriate treatment to completely restore the riding quality and structural integrity of the pavements, the use of multi-indices condition indicators is most effective. Moreover, on NH/SH and city roads, there is a difference in the form of distress. A single and standardized pavement condition index (PCI) framework can therefore

not be widely accepted. The Pavement Condition Index (PCI) should be unique to the road network, tailored by road category, traffic type, environmental condition, etc.

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