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Predicting the Future Service Life of Road using Pavement Condition Index

Arati Potdar[1], Shantanu Wadkar[2], Ruturaj Desai[3], Rushikesh Patil[4], Gaurav Tatkare[5]
[1, 2, 3, 4, 5] *Civil Engineering Department, Shivaji University*

Abstract: Pavements are major the assets of highway infrastructure. Maintenance and rehabilitation of such pavements to the desired level of serviceability is one of the challenging problems considered by pavement engineers and administration in the highway sector. The evaluation of such pavement performance using pavement condition indicators is a basic component of every Pavement Management System. Various indicators like Pavement Condition Index (PCI) as well as Present Serviceability Rating (PSR), Roughness Index (RI), etc. has been commonly used for assign a maintenance strategy for the existing pavements. The methodology which includes identification of urban road sections, pavement distress data collection, development of individual distress index and finally developing a combined PCI for the network. The four performance indices viz. Pavement Condition Distress Index (PCIDistress), Pavement Condition Roughness Index (PCIRoughness) and Pavement Condition Structural Capacity Index (PCIStructure) as well as Pavement Condition Skid Resistance Index (PCISkid) are developed individually. Then all these indices are combined together to form a PCI giving importance to each indicator. The proposed index is expected to be a good indicative of pavement condition as well as performance. The developed PCI was used to select the maintenance strategy for the pavement section.
***Keywords**: Pavement Condition Index; future service life; road; overlay; PSR.*

I. INTRODUCTION

Pavement condition evaluation which includes evaluation like distress, roughness, friction and structure is one Of the most important components of pavement design, rehabilitation and management. The condition indicator is used to represent the pavement condition of selected pavement. The developed index is based on four performance indices which are Pavement Condition Distress Index (PCIDistress), Pavement Condition Roughness Index (PCIRoughness), Pavement Condition Structural Capacity Index (PCIStructure). Road pavement structures very often would not reach the service life as planned because the number of reasons such as the number of repetitions axle designs carried by road pavement is greater than planned values. Repetition of larger axis will also impact on the value of the condition of pavement faster than planned. As the result of many factors causing damage to roads, road serviceability age uncertainties arise and so that the remaining life of a pavement service life is difficult to predict. Uncertainty of service life will obviously affect the integrity of the planning that has been used as a reference and to influence the handling of the priority an road rehabilitation plan at a long term period in a certain road. Therefore, the aim of this research is to find out the pavement condition and to calculate the remaining service life of the existing road based on a Pavement Condition Index.

This paper presents the pavement performance evaluation for Sangli-Kolhapur highway, near Kolhapur city. The condition indicator used to represent the pavement condition of selected road sections is, combined Pavement Condition Index (PCI). The developed index is based on four performance indices viz. which are Pavement Condition Distress Index (PCIDistress), Pavement Condition Roughness Index (PCIRoughness) as well as Pavement Condition Structural Capacity Index (PCIStructure) and Pavement Condition Skid Resistance Index (PCISkid).

These indices was developed individually and were then combined together to form an PCI for giving importance of each indicator. The pavement condition data was collected in the year 2018, which included measurements of longitudinal and transverse cracking, alligator cracking, rut depth, patching, roughness, structural deflection and skid resistance for all the selected road sections. All the individual condition indices and the combined index are suitably ranged from the value 0 to 100.

The pavement condition is rated based these values as 0-10: Failed; 10-25: Very Poor; 25-40: Poor; 40-55: Fair; 55-70: Good; 70-85: Very Good; 85-100: Excellent.

This traffic load, many factors causing the damage to the pavement, such as, the quality of construction works that do not meets quality standards, poor maintenance, flooding and water scouring, basic soil characteristics that have development potential and high shrinkage, and other design factors .

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II. RESEARCH METHOD

A. Research Location

The location of this research was the Sangli-Kolhapur highway at atigre, Kolhapur. The map of location and the road network is shown below in fig.1

Fig.1 Map of research location of Sangli-Kolhapur highway at Atigre.

B. Data collection And Analysis

The procedure of data collection started by determining the road segment near to the Kolhapur City. The selected road segment have varied visual condition, ranging from very poor condition to excellent pavement condition.

The detailed assessment and calculation of PCI and were then conducted to collect all the required data for the road condition, according to standard PCI Procedure. The data is to be estimate the remaining service life of the pavement were collected with the measurement of Benkelman Beam Deflection (BBD), consist of the deflection data, air temperature, the surface layer temperature of the pavement, the ground water level, seasonal factors as well as layer structure and the traffic data. The proper illustration of data collection with BBD is presented in Fig.2.

Fig.2 Benkelman Beam Deflection measurement to collect pavement data

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The data collected from PCI survey and BBD measurement were then it is calculated and analysed for find out the values of PCI at every selected based on ASTM and the remaining service life of the subsequent road pavement were also analysed and calculated based the results data from BBD. Based on the temperature data, the structural data of the pavement layer, the deflection data from BBD , the strength of an pavement structure of each road segment was calculated based on the no of existing Cumulative Equivalent Standard Axle (CESA). Based on existing CESA and existing traffic data the remaining service life on the road should be calculated.

III. PAVEMENT CONDITION INDEX

The data of pavement deterioration of every sample unit for each road portion are obtained directly for the road location. The results of the survey data are then calculated to obtain the value of PCI of each selected unit. The average value of a sample in a single PCI unit of road portion is the value of PCI on road portion that are reviewed. The PCI value of the segment is the average value taken. The interpretation of the condition of PCI value obtained by the referring to the scale of assessment which is presented in below table and illustrated in Fig.3.

Table 1. M & R strategies which based on PCI

PCI value	Pavement Condition Rating	M & R Strategies	Suggested Maintenance Alternatives
85-100	Excellent	Routine Maintenance	Patching, Pothole filling, Crack seal
70-85	Very Good	Preventive Maintenance	Chip seal, Micro surfacing, Thin overlays, For seal.
55-70	Good	Rehabilitation	Thick overlays, Mill & overlays, Full depth patching.
40-55	Fair		
25-40	Poor		
10-25	Very Poor	Reconstruction	Full depth reclamation.
0-10	Failed		

IV. THE CORRELATION BETWEEN PCI VALUES AND THE REMAINING SERVICE LIFE

The data used in this analysis are the value of PCI and the remaining service life is calculated based on the deflection from BBD measurement. The correlation in between the value of PCI and the remaining service life should carried out by using the Microsoft Excel programme.

In terms of its relation to the estimate need for the treatment and rehabilitation of selected roads, pavement remaining life prediction based on the functional failure is easier than those who based on structural failure. PCI value may help to identify the segment, which needs to be conducted a preventive maintenance in order to prevent the further deterioration of road.

Based on the limitation, the graph which is developed to predict the remaining service life based on PCI values. However, further research is required to understand in detail this is relationship for better understanding of this correlation.

Table 2 :- Measurement of deflection by Benkelman beam

Sr. No.	Deflection (D) in 'mm'.	Temperature in °C	Temperature Correction °C	Corrected Deflection (mm)	Davg (mm)	$(Davg-D)^2$
1.	1.1	32	-0.01	1.09	1.08	$1x10^{-4}$
2.	1.02	32	-0.01	1.01		$4.9x10^{-3}$
3.	0.9	32	-0.01	0.89		0.0361
4.	0.87	32	-0.01	0.86		0.0484
5.	1.14	32	-0.01	1.13		$2.5x10^{-3}$
6.	1.3	32	-0.01	1.29		0.044
7.	0.94	32	-0.01	0.93		0.225
8.	0.88	32	-0.01	0.87		0.044

V. RESULTS

PCIstructure = 43.15
PCIdistress = 37.18
PCIroughness= 59.16
Avg.PCI = 46.49.
Thickness of the bituminous overlay = 60mm.
From the above values the condition of the road is FAIR.

VI. CONCLUSION

The study was primarily aimed to use the outputs of different pavement condition indicators of flexible pavement sections deciding the M&R requirements. Pavement structural strength was found to be a important pavement condition indicator for changing the pavement performance and deciding the M&R strategy for selected pavement section. Structural capacity is one of the important from the fact that mostly the pavement are rehabilitated or reconstructed due to inherent structural weaknesses. Therefore it can be used to filter the pavement sections that should be selected to work on project level. So here we have to go for maintenance of the road for which we are going to provide the bituminous overlay with thickness of 60mm.

It can be stated from the study that using the pavement condition index is much reliable as well as efficient in selecting the appropriate treatment to fully restoring the riding quality and structural integrity. Further research is recommended to developing the predictive models considering the pavement condition index (PCI).

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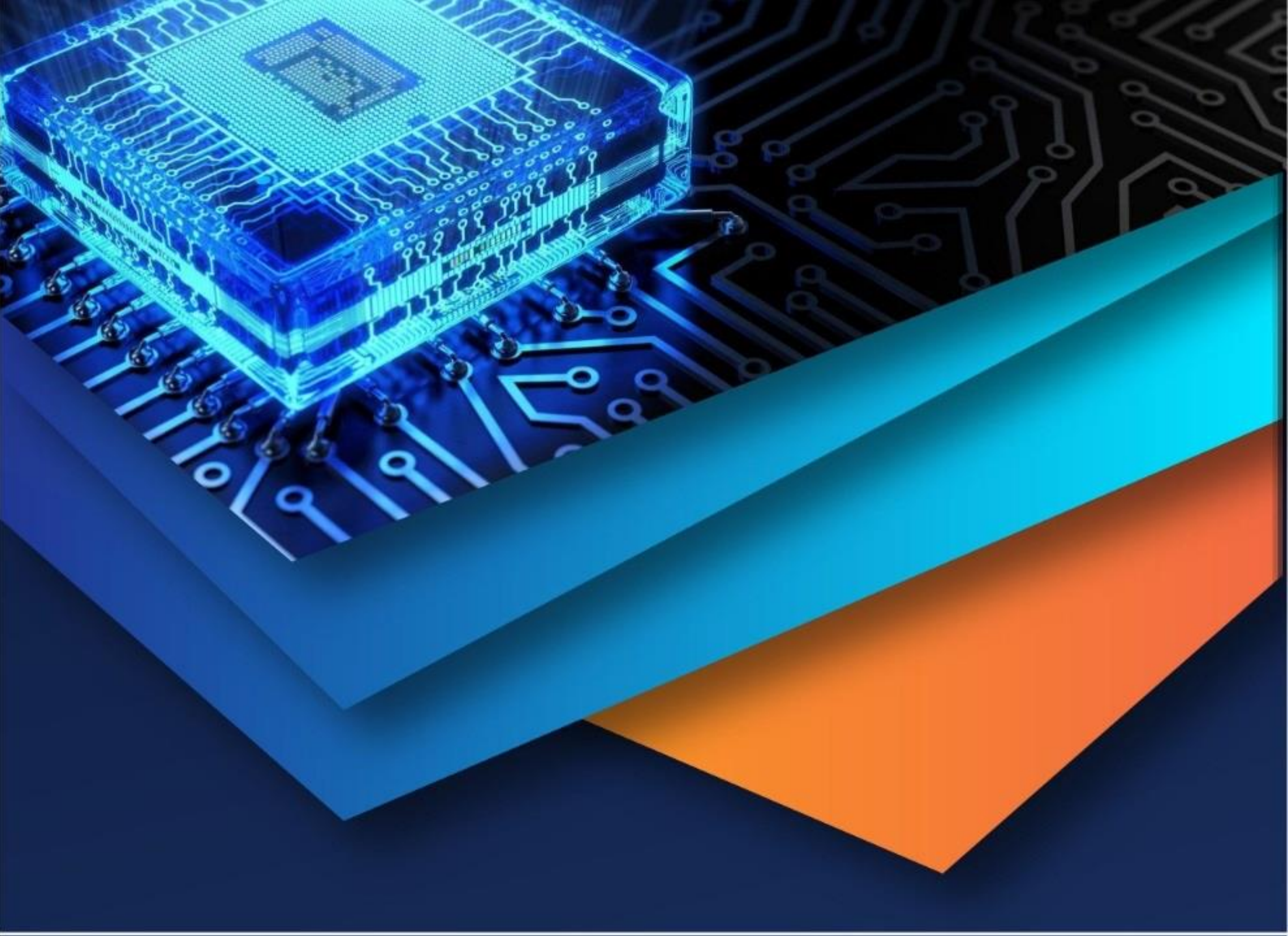

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