Surface Distress Analysis of Flexible Pavements: A Comparison of Rating Methods

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Abstract—**After excessive needs for pavement maintenance, rehabilitation and the limitation of available fund it is require doing pavement distress analysis and pavement condition rating for flexible roads. Distress analysis and pavement condition rating is use for maintenance budget. It is commonly found that rate of wearing and tearing of flexible roads changes from good condition to sever condition within a decade of time. The study is carried out of 59 km length road from the different location of Six Laned Pimpalgaon-Nashik-Gonde NH-03. The lanes are surveyed to find out different distresses conditions based on Indian Road Congress (IRC) and WSDOT Guidelines. The importance of this study is also that, it will helpful to the agencies for use of most suitable method of PCI calculation. To compare both the methods the similarity study and correlation analysis is carried out. The study identified nine types of distresses from which best maintenance rehabilitation strategies are proposed. This study gives solution for urgent repairing and maintenance of damaged roads.**

Index Terms—**Distress analysis, Physical survey, Pavement condition index, Correlation analysis**

I. INTRODUCTION

The concept of pavement distress analysis and pavement condition rating for flexible pavements came into practice in the last decade due to an excessive need for pavement maintenance and rehabilitation and the limited available fund. The goal of distresses analysis is to rate the pavement and use the maintenance budgeted optimally. Under the normal traffic, the rate of deterioration of a pavement changes from excellent to good within 10-12 years after construction. The maximum life of the pavement generally does not exceed more than 16 years. And by the 12th year there will be 40% decrease in the quality of the pavement and in the next 4- 5years there is an additional 40-50% decrease in the quality. When the pavement gets deteriorated the cost associated with the maintenance is increased. The cost of preventive maintenance of a deteriorated surface is 67 INR before 12th year, but after the 12th year the cost increases to 268- 335 INR. In the Indian scenario, due to the poor condition of roads, it is estimated that an annual loss of approximately over Rs. 6000 crores ($1.33 Billion) is resulted in Vehicle Operating Cost (VOC) alone. The timely maintenance is missing due to many reasons, which otherwise could have minimized the losses to the exchequer. A rough estimate suggests that more than 50% of the primary road network is in bad shape needing immediate attention. It should be borne in mind that to achieve the desired economic growth, the foremost requirement is to ensure a good and an effective road network. There is room for improvement in all aspects of the pavement management process. Quality criteria need to be updated periodically using basic statistical tools. All quality management procedures must be well documented to help improve future data quality control and assurance procedures. With quality and reliable data, pavement management will be improved and this will ultimately lead to efficient use of pavement assets.

A. Objectives of project

1. To understand and analyze the concept of Pavement Condition Rating (PCR) Method.

2. To identify the different types of pavement distresses in flexible pavements.

3. To compare and evaluate the effectiveness of the PCR method for distress analysis.

4. To analyze the data and generate a comparative study of PCR with other distress evaluation

methods.

5. To evaluate the impact of environmental and traffic conditions on pavement distress.

6. To develop a set of recommendations for improving distress analysis and road maintenance strategies.

7. To calculate the Lane-wise Pavement Condition Index (PCI) for the selected flexible pavements.

8. To perform a comparative study between PCI, HPs, and other distress evaluation methods.

9. To validate the accuracy of PCI and HPs values with real-time data and field conditions.

II. LITERATURE REVIEW

Madhavendra Sharma, Pradeep Kumar, Sanjeev Kumar Suman (2019) the study presented on Pavement Condition Rating Models for Flexible Pavements All Civil Engineering structures deteriorate with time and pavements being no exception undergo deterioration with time. The various factors that influence the deterioration process of pavements include traffic loading, climatic conditions and quality control during construction among others. An efficient Pavement Management System (PMS) is the need of the hour for maintenance of huge and rapidly growing road network of India. One of the major components of an efficient PMS is the Pavement Condition Rating (PCR) model. PCR quantifies the present pavement condition of a pavement into numeric form on the basis of functional and structural parameters that affect the pavement health.

Anurag Sinha, Pratik Hagawane (2020) gives Method Comparison of Pavement Condition Rating based on IRC & ASTM Guidelines. In a developing country highway infrastructure is the backbone for economic development. With increase in traffic and loading, pavement detoriation occurs which needs to be monitored and captured continuously for preparing efficient maintenance proposals. Pavement condition rating through various distress identification and measurement is the need of an hour. The paper reviews the methodology and result of pavement condition rating by IRC & ASTM method over the four lanes 80 Km flexible pavement section. The pavement ratings obtained by both of the methods are compared to each other to find out the correlation, accuracy and precision in results. The paper gives the concise view of pavement performance rating. This will help in finding the effectiveness and usefulness of each model

of pavement ratings. Sachi Kodippily, Tenuis F.P. Henning, And Jason M. Ingham, (2012). This Paper presents the correlation between flushing and factors likely causing flushing on thin-sprayed seal pavements. Surface flushing is dependent variable, while other four causes of flushing such as pavement composition characteristics, traffic related factors, Climatic factors, and effects of other pavement defects are independent variables. The analysis revealed that surface thickness and age have positive relationship to flushing. Also, water content of soil has positive relationship with flushing, and relationship between dry density of soil and flushing was found to be negative. Traffic volume and heavy vehicle have no relationship with flushing

Saeed Ghaffarpour Jahromi (2015) This paper discusses about the use carbon nanofiber on behaviour of asphalt concrete. It pin points other materials such as Nano calcium carbonate which had been used for asphalt modification, and it had its impact on properties of asphalt such as increase in rutting resistance. But this paper, claims that by using carbon Nanofiber, the mechanical properties of asphalt will improve such as strength and fatigue characteristics of asphalt. The content of Carbone nanofiber in the upper-mentioned experiments ranges from 0.1-0.5 percent of the weight of bitumen. The maximum stability value from Marshal stability test is derived by 0.4% Nanofiber content. It is shown that presence of Nanofiber decreases the flow value of the bitumen. Presence of Nanofiber increase voids in the asphalt, maximum voids can be achieved by 0.4% of Nanofiber. Nanofiber content of 0.4% increase the resilient modulus (stiffness) of the asphalt. Also, Nanofiber content of 0.4% decrease the permanent deformation of the pavement. As well as its presence will decrease fatigue in to a huge extent.

III. METHODOLOGY

Research methodology is divided in three phases.

A. Phase 1

B. Phase 2

C. Phase 3

Phase 1:

This phase includes Literature review, objectives and problem statement which are based on research area that have been selected as case study of Urban.

Phase 2:

The site visits were conducted frequently to identify the types of distresses, and actual measurements of the distress are taken. To identify severity and extent distresses.

Phase 3:

On the basis of actual data collected from 59km six laned of Nashik-Pimpalgaon-Gonde cities. The PCI values are

determined also Severity is calculated based on IRC and HPS manuals of distresses analysis. And then the correlation analysis is carried out to comparison between the two methods. The research methodology is given in below table.
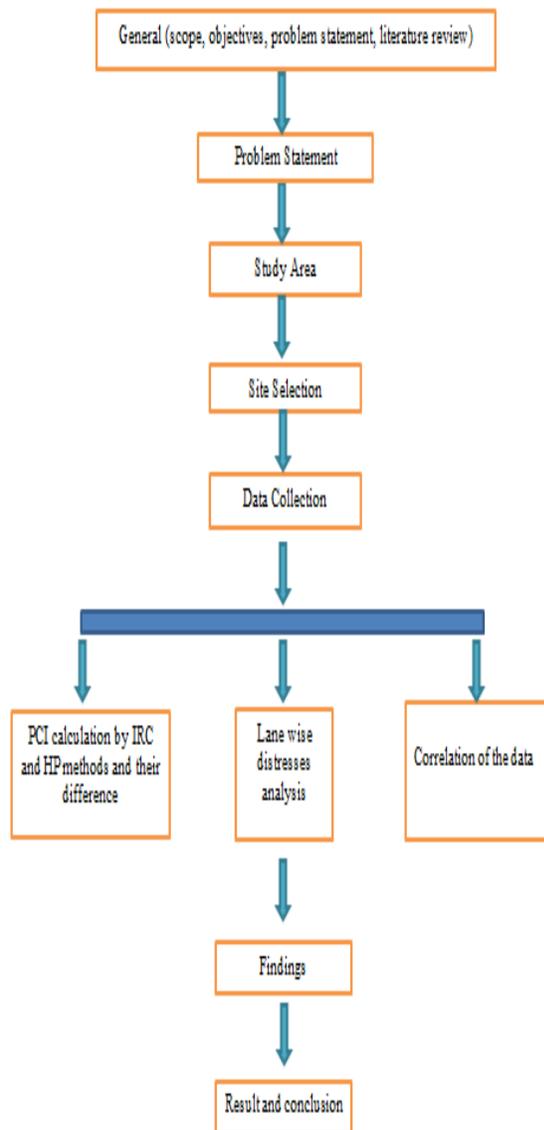

Figure: Research Methodology

IV. DATA COLLECTION AND ANALYSIS

The data is collected within the 59 km road urban and MDR roads of Nashik-Pimpalgaon-Gonde cities by visiting the roads by physical inspection for the surface distress. Each lane is individually surveyed for 100m length and an average width of 7m. Using IRC, the distress is measured and recorded in standard format. Data and Pictures are recorded are tabulated in the Microsoft excel and complete data is created for the entire 59km length roads.

A Distress analysis:

To find out further facts about this deviation the distress wise analysis is to be carried out. To carry out the distress's analysis the IRC and WSDOT distresses identification manuals are used. The detailed distress wise analysis is shown in appendix 3.

The matching and mismatching criteria of distresses between both the manuals have been determined. The matching and mismatching criteria for the distress's identification for the severity and extent based on IRC and WSDOT shows in below table.

S.N.	Distress Type	Severity	
		Matching %	Mismatching%
1	Patching	51.35	48.65
2	Raveling	40.91	59.09
3	Pothole	78.57	21.43
4	Alligator –Cr	100.00	0.00
5	Bleeding	28.00	72.00
6	Longitudinal –Cr	100.00	0.00
8	Edge breakage	71.43	28.57
8	Shoving	33.33	66.67
9	Settlement	100.00	0.00

Table 1 Matching and Mismatching Criteria by Percentage

The table 1 shows nine type distresses found in all lanes. The percentage wise matching and mismatching criteria between both the methods. It is to be found out

that in to what extent the severity and extent analysis matches and both methods give the same result and wise verse.

Distress wise matching and mismatching criteria of IRC and WSDOT distresses
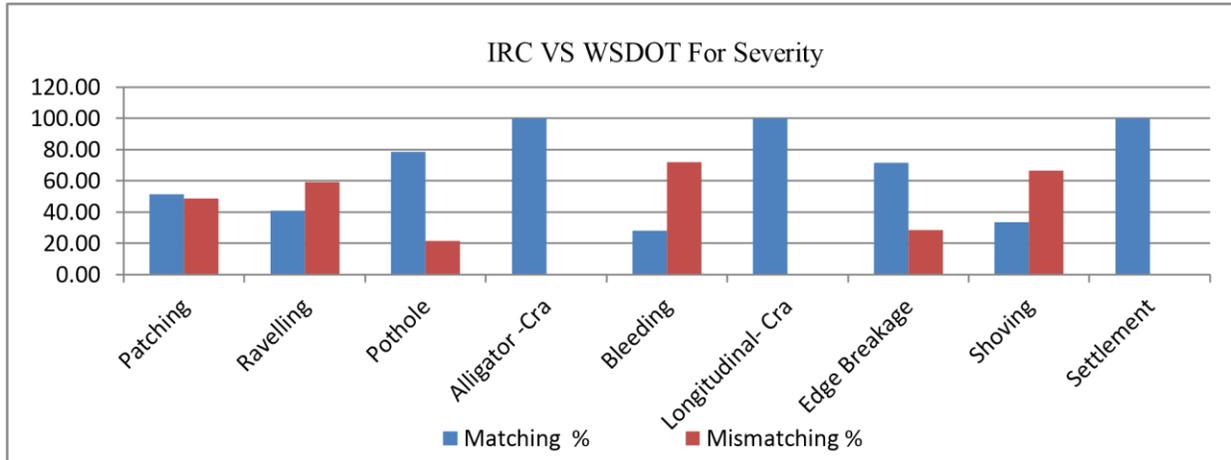The graphical representation of table 1 is under.

Figure 2: severity

Inference from figure 2 of severity is:

a) Raveling, Alligator cracking, longitudinal cracking, Settlement, Shoving are the forms of distress that both the manuals give the same result for severity analysis.

b) Patching, Bleeding, are the forms of distress that both the manuals in general give 50% (more or less) matching and 50% (more or less) mismatching result for severity analysis.

c) Edge breakage, Pothole is the form of distress that both IRC and WSDOT give the opposite result for severity analysis.

V. RESULT

Percentage wise categorization of similarities between IRC and WSDOT for severity and extent
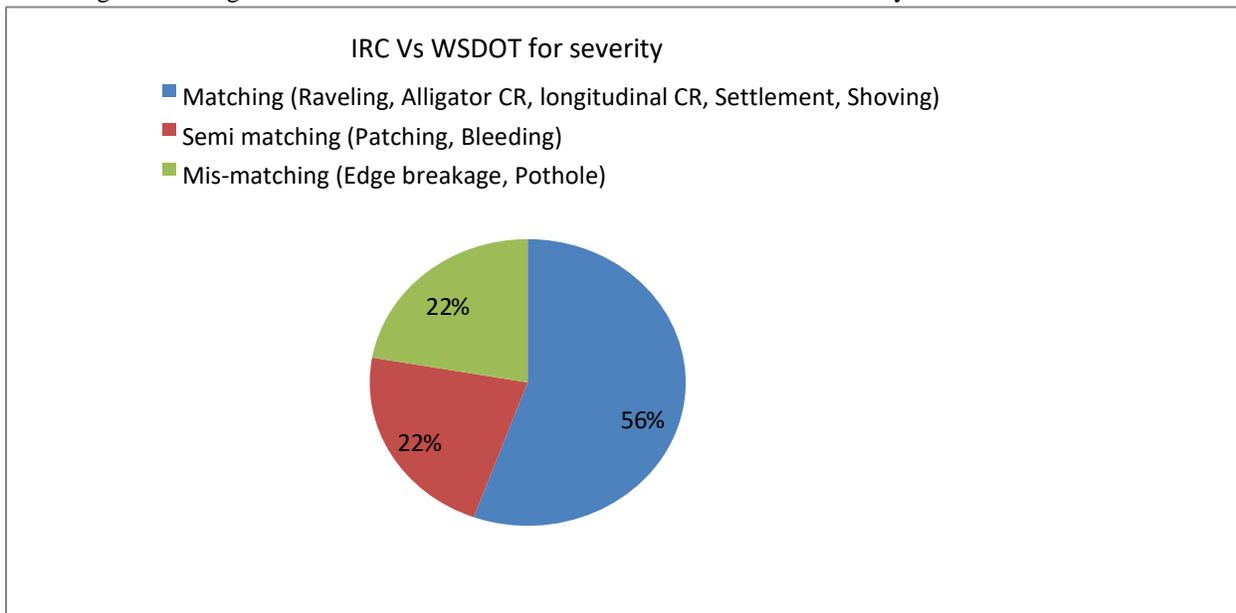
4 Indicates (in case of severity):

a) Out of the observed common types distresses for 56% of the distresses IRC and WDOT gives the highly similar result.

b) Out of common types of distresses for 22% of the distresses IRC and WDOT gives the less similar result.

c) Out of the observed common types of distresses for 22% of the distresses IRC and WDOT give the opposite result.

VI. CONCLUSION

To summarize, it is important to state that lanes of flexible roads from Nashik-Pimpalgaon-Gonde cities are investigated and the distresses are recorded. Based on this actual data, the Indian based method of PCI calculation and a European based HPS for PCI calculation have been compared. Lane- wise PCI values are calculated.

a) The PCI values are calculated for 50 lanes urban flexible roads based on 1-3 points rating scale by IRC method and based on 0-100 points rating scale by HPS.

b) Correlation analysis has been carried out and it results on a very weak correlation coefficient between IRC method and HPS is (0.1722)

c) Based on the analysis the similarities between IRC and WDOT are investigated for severity. It is resulted that in case of severity for 56% out of 100% IRC and WDOT give the highest similar result. And at the rate of 22% out of 100% they give the medium similar result. However, for 22% they mismatch.

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