Evaluation of Pavement Performance Index using Distress Parameter for Nagpur City

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Abstract

For urban road there is no definite performance indicating procedure. There is a procedure to find out pavement condition index. This procedure is depending on two factor namely severity and extent. We are evaluating the pavement performance by considering seven parameters which are causes to pavement deterioration. To find out the pavement performance index weightage of each deteriorating factor is required. To give the weightage to each deteriorating parameter on the basis of severity we use analytical hierarchy process (AHP). Before giving input to AHP we first normalize the data by simple mathematical equation. Rating guidelines developed on the basis of research paper and data collection for both severity and extent. Each distress having rating from 0-5 where 0 is bad performance and 5 is very good performance of road stretch. AHP gives the consistency ratio; if this consistency index fails to reach a required level then answers to comparisons may be re-examined. In this study the consistency ratio is less than10%. We have done survey on 1.8km stretch from Sunday market jaitala to Mokhare College. We found out all deteriorating parameter rating by finding their values. The pavement performance index is found out by adding and multiplying each pavement deteriorating parameters rating with their respective weightages.

Keywords: Pavement, Deteriorating Parameters, AHP, PPI, Maintenance

I. INTRODUCTION

A. General

Road transportation engrosses the paramount position in the total transportation mode of system in India. The entire development of country is fully rest on the road linkage. Economic point of view the country roads are discursively contributed to the overall development of nation. So it is needful that the roads are strong and give better performance in all circumstance. Orange city Nagpur is shortlisted for smart cities mission of Indian government. The connectivity of road and the performance of the road are important for wandering. Good performance of road gives comfort to the road user. In Nagpur there is rapid growth of industries, growth of population is also increase day by day and number of vehicle user are also increases. Nagpur metro which is under progress, so it is critical to give better execution of adaptable asphalt to the general population.

Streets are critical foundations that effectively endure bothers because of their consistent use. The asphalts are intended for a normal administration life or plan life. At the point when pavement keeps going longer than its expected life, it might have been overbuilt and the first cost may have been too high. At the point when pavement flops before its proposed plan life, the street takes inordinate repair and support costs. What It Is: The asphalt execution Index rates the state of the surface of a street organizes. The pavement performance index will help road managers for understanding the current circumstance of the street benefit level and to decide alluring upkeep techniques.

Various types of distresses which are observed on road decrease the pavement performance and as the performance of rod decreases the travel time increases. Potholes, cracks, edge failure, raveling, rutting are some of harmful distress which reduce the whole pavement performance.

B. Need of Study

For the change of urban street condition, there is a need to build up an arrangement of strategies that will give an orderly assessment of pavement surface needs, in light of fitting designing choice and master learning and in the meantime to figure out which street extends require support and which are the segments for which the upkeep operation can be conceded. Under Nagpur city all roads were constructed by Nagpur Municipal Corporation are in crumbling stage. Improvement of these roads is the demand. For maintenance of the road in comparable minimum time and for identification of road which required maintenance, study is required.

C. Objective

- Originate the weightages of various distresses which are inspected on the road surface.
- Assessment of various distresses in terms of severity.

- Assessment of various distresses in terms of extent.
- To assess the PPI estimation of various section of road stretch.

II. LITERATURE REVIEW

Abhay et al. (2016) evaluate the performance index on the basis of distresses parameter for bucolic roads. Author conducts questionnaire survey for calculation of weightage for various distresses parameter. For this questionnaire survey for 117 professionals participated. Ajinkya et al. (2016) suggested the guidelines for the development of various distresses rating. They give the rating on the basis of numeric scale of 1 to 5. Hari et al. (2010) they evaluate flexible pavement distress by using fuzzy logic and expert system. Author pigeonhole various distresses by seeable inspection on flexible pavement. Yogesh et al. (2013) developed overall pavement condition index of flexible pavement for Noida city. Author established condition index for pavement, roughness index for flexible pavement, index for structural capacity and index for skid resistance. Prachallaja et al. (2016) they study on the three types of distresses raveling, rutting and potholes. For the study authors selected 39.9 km stretch of urban road of Hyderabad city. For the consideration of distress parameter, they used visual survey method. Juang et al. (1992) developed road distress index for piloting flexible pavement. Author used priority ranking method for the management of flexible pavement in United States. Author take guidelines from Ontario transportation ministry (manual 1982) and give description and rating on numeric scale. Vishwanath et al. (2013) developed the policy for the management of the arterial roads. The index rating of road is based on the situation of road. 0 – 100 rating was referring by author, where 0 is required rehabilitation and 100 does not required any maintenance. Jiguang Chen (2011) proposed that the technique keeps away from limited esteem estimation of middle esteem in the past general assessment of asphalt execution and the unverifiable factors. The strategy for interim number general guess pertinent choice was receive to assess asphalt execution, and another path for asphalt operational execution would be given. Klaus D Goepel (2016) developed AHP-OS is a web-based tool to support rational decision making based on the Analytic Hierarchy Process (AHP). It allows you to define a hierarchy of criteria for a decision problem, to calculate priorities and evaluate a set of decision alternatives against those criteria.

III. STUDY AREA AND FIELD DATA COLLECTION

For the study, road stretch is divided into 100m section. The current flexible pavement condition at first surveyed by visual investigation of the choose road stretch (IRC: 082-1982), (Distress identification manual FHWA-RD-03-031). Total 18 sections are considered for rating guidelines.

After Mumbai and Pune with a spatial spread over an area of 257 sq. km and a population of 2.4 million (Census 2011). Nagpur is the 13th largest urban agglomeration in India and the largest city in Vidarbha Region.

Table – 1
Location of the roads

Name of road	*Length (km)*	*Width (m)*	*Number of section considered*
Sunday market Jaitala to mokhare college	*1.8*	*12*	*18*

Quantify the distress in terms of severity and extend and normalize the data by using equation (1)

$$\bar{X} = \frac{X_i - X_{min}}{X_{max} - X_{min}} \text{---------- (1)}$$

Where $X = (X_1 \ldots . X_n)$and $\bar{X}$ is the i^{th}normalized data.

IV. METHODOLOGY

Improvement of distress rating rules is an exertion of broad and detail distress survey. In present review, distresses are manually distinguished and evaluated. Categorization of distress and positioning them with respect to extend and severity is a vital stride for pavement condition evaluation. AHP remains for Analytic Hierarchy Process. It is a technique to support multi-criteria basic leadership and was initially created by Prof. Thomas L. Saaty (1980). AHP gets proportion scales from matched correlations of criteria and takes into account some little irregularities in judgments. Sources of info can be genuine estimations, additionally subjective assessments. Thus, proportion scales (weightings) and a consistency file will be computed.

AHP STEPS

1) Step 1 – Define a hierarchy
   The problem is decomposed into a hierarchy of goal, criteria, sub-criteria and alternatives. This is the most creative and important part of decision-making.
2) Step 2 – Compare criteria
   To find the weight (importance) of criteria, compare each pair of distress by using scale 1-9, where, 1 is equal importance and 9 has extremely strong importance. It could happen that if pairwise comparisons are not consistent; then the most inconsistent judgments are highlighted, and the consistent judgments are marked light green.
3) Step 3 –calculate global weightage and consistency ratio
4) Step 4 –Alternative Evaluation
5) Step 5 –Get ranking

V. PAVEMENT PERFORMANCE INDEX

The formula used for calculate the PPI for each section is as below,

$$PPI = \sum(R_i * W_i) \text{---------- (2)}$$

R_i= rating of each distress parameter
W_i= weightage of each distress parameter

VI. RESULT AND DISCUSSION

Table – 2
Guideline developed on the basis of research papers and data collection for distress rating with respect to severity.

Type of distress	*Parameter consider for defining severity*	*5 (minimum)*	*4*	*3*	*2*	*1 (maximum)*
Pothole	*Depth (cm)*	*<1*	*1-3*	*3-4*	*4-5*	*>6*
Fatigue crack	*Width (cm)*	*<0.5*	*0.5-1*	*1-1.5*	*1.5-2*	*>2*
Longitudinal crack	*Width (cm)*	*<0.5*	*0.5-1*	*1-1.5*	*1.5-2*	*>2*
Transverse crack	*Width (cm)*	*<0.5*	*0.5-1*	*1-1.5*	*1.5-2*	*>2*
Rutting	*Depth (cm)*	*0.5-1*	*1-1.5*	*1.5-2*	*2-2.5*	*>2.5*
Ravelling	*Visual inspection*	--	--	*Surface texture very rough*	*Aggregate and binder worn away*	*Completely loss of aggregate*
Cutting edge	*Width (cm)*	*<15*	*15-20*	*20-35*	*35-50*	*>50*

Table – 3
Guideline developed on basis of research papers and data collection for distress rating with respect to extent.

Type of distress	*Parameter consider for defining extent*	*5 (minimum)*	*4*	*3*	*2*	*1 (maximum)*
Pothole	*No of pothole*	*0*	*0-3*	*3-6*	*6-9*	*>9*
Fatigue crack	*% Area covered with crack*	*0*	*0-3*	*3-6*	*6-9*	*>9*
Longitudinal crack	*% Length*	*0*	*0-3*	*3-6*	*6-9*	*>9*
Transverse crack	*% Length*	*0*	*0-3*	*3-6*	*6-9*	*>9*
Rutting	*% Length*	*0*	*0-2*	*2-4*	*4-6*	*>6*
Ravelling	*% Area*	*0*	*0-5*	*5-10*	*10-15*	*>15*
Cutting edge	*% Length*	*0*	*0-2*	*2-4*	*4-6*	*>6*

Table – 4
Computation of pavement performance index

Road sections (m)	$\sum(W * R)$	*Performance*
0-100	*2.38*	*Poor*
100-200	*1.76*	*Poor*
200-300	*1.49*	*Poor*
300-400	*3.00*	*Fair*
400-500	*1.73*	*Poor*
500-600	*2.51*	*Poor*
600-700	*No distress found*	*Very good*
700-800	*3.80*	*Good*
800-900	*4.00*	*Good*
900-1000	*No distress found*	*Very good*
1000-1100	*4.00*	*Good*
1100-1200	*No distress found*	*Very good*
1200-1300	*No distress found*	*Very good*
1300-1400	*4.00*	*Good*
1400-1500	*1.86*	*Poor*
1500-1600	*2.06*	*Poor*
1600-1700	*2.25*	*Poor*
1700-1800	*1.90*	*Poor*

The mean value of pavement performance index is 3.15 this implies that the performance of road in the month February 2017 was fair and repair and maintenance work is required in near future.

VII. CONCLUSION

The research study concentrates on initiating the simple and logical approach for flexible pavement management system of urban roads in India, where it is hard to get authentic time arrangement distress information and data about repair and maintenance work did before. In this paper various distress observed manually and quantify in terms of severity of distress and extend of

distress. Rating guideline is developed on the basis of research papers and data collection. AHP gives the weightages of various distress parameters, And the pavement performance index simply suggested the performance of road. Thus this procedure can be embraced by field engineers, leaders for effective budget distribution for maintenance or safeguarding of road.

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