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Research Article

EVALUATION OF PAVEMENT CONDITION OF RURAL ROADS UNDER PMGSY FOR MAINTENANCE AT PATNA

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ABSTRACT

Road is very important transportation as mean of right to use for the community that lives in rural area. The aim of this paper is to assess the pavement surface condition of rural roads within district Patna, Bihar. A video graphic survey was conducted and image was analyzed by image processing. Total thirteen numbers of roads was surveyed. The roads are divided into a numbers of km for the pavement condition index determination, hence total number of sections become thirty seven. Distresses like potholes and raveling is common to all the roads. It is found that 11%, 22%, 13%, 16%, 19% and 19% of 37kms roads length are in condition namely excellent, very good, good, fair, poor and very poor respectively.T01 to TotaBigha road, condition of road was Excellent. Sohghi more PMGSY roads to sampatchak road, condition of road was 75% very poor and 25% excellent. L057 to Ekauna road, condition of road was 66% poor and 34% fair.It was observed that 67.57% roads have age around four years while 32.43% roads have age more than four years. It means pavement deteriorated rapidly hence required maintenance frequently.

INTRODUCTION

Pavement condition assessment is essential component of pavement management system for maintenance and rehabilitation of pavement. Roads not only provide an ease to transport but also lead to social and economic development of the area from where the road is passing. Rural roads contribute around 70% of the total road network in India. The Pradhan Mantri Gram Sadak Yojana (PMGSY), was launched by the Govt. of India to provide connectivity to unconnected Habitations as part of a poverty reduction strategy. Rural roads in Bihar are 15,130km, out of this 11,243km roads are converted into paved one. Now, PMGSY Phase-III has arrived for maintenance and upgradation of existing constructed roads under Phase-I and II. Therefore, pavement condition assessment is essential to provide the right material at place in right time with optimum cost. Manual pavement surface condition assessment is time taking process, laborious and unsafe. When the pavement condition evaluated incorrectly, treatment cost will not reasonable. Hence, there is a need for developing a new procedure for assessing the pavement condition, which can reduce these drawbacks. A video graphic survey along with image processing method is one of the solutions.

Ouyang *et. al*. (2011) determined the Pavement cracks with the help of digital image processing having its advantage of collection of large amount of information and automatic detection. Cheng H D (1998) discussed a new technique i.e. pavement distress enhancement algorithm for determining the pavement distress. This method was severely able to quality about the geometrical and topological parameters of the distress. Joonkee Kim (2000) had developed a low cost pavement imaging system using video technique to calculate the crack index. Statistical technique was implemented while analysing the calculated crack index and results was able to predict the repeatability of the images. TeiborlangLyngdoh (2011) carried out distress studies on the four rural roads in Assam. Pavement condition rating was fair to satisfactory in two years. Yong Hua *et. al*. (2014) worked out on the texture analysis and shape detection technique, which can be used for identification of pavement cracks. They considered surface texture of the pavement and distress of the pavement surface to be non-homogeneous in nature. They found that cracks could be easily detected by this new Novel method.The objectives of this paper are (i) to present a method to determine the pavement condition using video graphic technique of low volume roads of Patna, Bihar and (ii) To evaluate the Pavement Condition Index (PCI) using PAVER method.

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METHODOLOGY

To assess the condition of pavement, survey was carried out on thirteen low volume roads constructed under PMGSY nearby Patna town. Total length of roads is 37km and they are black topped pavement. Layers thickness of pavement from bottom to top are 300mm (subgrade), 175mm (Granular subcase), 75mm (WBM-II). 75mm (WBM-III) and 20mm (premix carpet).

Video graphic survey

A digital camera was fixed in bike handle at inclination often degree with the horizontal towards the surface of pavement so that the camera captured whole width of pavement. The bike was moving with a speed of 20 kmph. The position of camera was at a height of 0.95m m from the road surface. This setup is kept constant throughout the work while collecting the video data (Fig.1).

Figure 1 Setup used for work

Scaling

Scaling is considered for conversion of units from pixels to linear measurement. For this purpose twenty samples are taken for the scaling. Figure 2 shows a linear relation giving coefficient of determination equal to 0.750.

Linear measurement in meter = 0.001 x pixel – 0.057

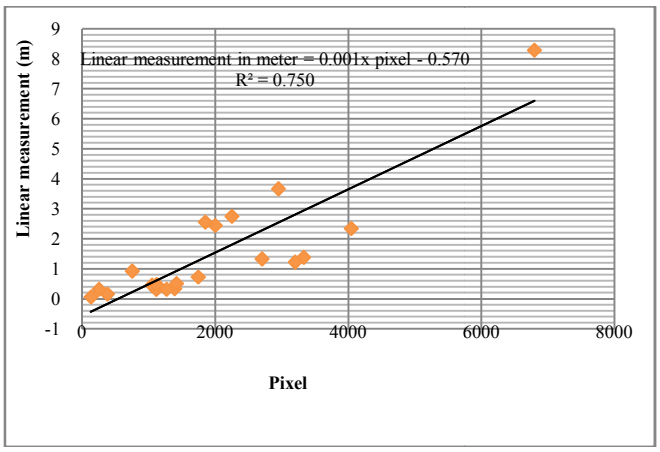

Figure 2 Relation between pixel (x axis) and meter (y axis)

Distresses Measurements

Rectangular and square Measurements

Generally in many distresses involve measurement in which length and its width is different, there rectangular shape was used, if length and width are same, square shape was used. Both the shapes can be monitored using the same command imrect. It was used in the measurement of alligator cracking, bleeding, block cracking, patching and utility cut patching, polished aggregate, weathering and ravelling.

The snipped image of MATLAB showing how to read any frame, the frame is 'IMG_20170117_141631.jpg'. Image so we use imrect function available in the image processing toolbox. When we use imrect function we see the screen as shown below and important to know the length and width of the distress, it can done by using data cursor provided on the MATLAB toolbox on the command window(Fig 3).

Figure 3 Raveling

Figure 4 Pothole

Figure 5 Longitudinal cracking

Circle and Ellipse Measurements

Some of the distress involves potholes its measurement in numbers i.e, counting of potholes but levels of severity of potholes depends on the diameter of potholes and depth of the potholes. Since as one of the limitations of this work is that with the help of single still image it is not possible to measure the depth of potholes. The diameter of the potholes can be measured as using the command imellipse. Figure 4 shows to capture the potholes from the image using imellipse.

Linear measurements

Linear measurement involves only one dimensional measurement and is used in different types of distresses such as edge cracking, longitudinal cracking, and transverse cracking. This makes use of imtoolfunction which helps to determine the length of edge, long & transverse cracks (Fig 5).

Road details and distresses

Name of the roads along with their length is shown in Table1. Number of distresses found on surveyed roads are indicated in the Table-2

Determination of Pavement Condition Index (PCI)

Distress Density

Distress density means the extent of distresses per unit. The amount of effected areas in each of the image or frames is expressed in terms of the total are of the sectioned considered. Distresses density can be measured for area, linear, number measured. Distress density depends upon distress amount, sample size area.

Distress severity

Severity means the amount to which any exacting type of distress is damaged. Severity is expressed in term of low (L), medium (M), high (H). Different types of distress contain different types of severity condition. The code ASTM D6433-07 explains about the calculation of distress severity for different distresses.

Pavement Condition Index

Pavement condition index is a numerical indicator rating of the pavement condition t ranging from 0 to 100 with value 0 being the worst possible condition and value of PCI 100 being the best possible condition. It gives the present condition of the pavement. Generally if the pavement is very old and condition is very poor then the pavement condition index is near to 0 but if the pavement is newly made then its condition has not deteriorated easily thus its pavement condition index is very close to 100. The pavement condition index is equal to 100 subtracted by corrected deduct value. The pavement condition rating varies from ***failed*** condition to ***excellent*** condition of the pavement.

PCI= 100 – CDV, CDV = f(N, TDV)

Where, PCI= pavement condition index, CDV= Corrected deduct value depends on TDV and N which can be determined from figure given in the code.TDV is total deduct value which is determined from the deduct values of individual distresses based on individual distresses severity levels which can be determined from standard figures given in the code used. N is number of distress parameters considered.

Table 1 Road details

Road name	Construction date	Survey date	Length (km)
L057 to Ekauna	25-01-2014	16-01-2017	5.37
T01 to TotaBigha	04-07-2015	17-01-2017	0.85
T02 to Behrawan	29-07-2010	17-1-2017	0.868
Parsasampatchak road to Khusalpurschool via Chiprakhurd	19-08-2010	22-10-2016	2.485
Punpunmurhar road to Nawada	04-08-2013	17-01-2017	6.239
PunpunNawada road to Paimar	17-08-2010	17-01-2017	0.661
T02 to Patanpura	21-06-2014	17-01-2017	1.960
T03 to Jolbigha	08-12-2013	17-01-2017	2.086
T02 to Dehri	23-05-2014	17-01-2017	1.740
DumariGauwaspur to Chaitbara	02-04-2009	17-01-2017	4
T03 to Maranchi	02-03-2010	17-01-2017	3.650
T06 to Chamuchak	22-07-2017	17-01-2017	1
Sohghi more PMGSY roads to Sampatchak	28-02-2011	22-10-2016	3.650

Table 2 Number of distresses road wise

Road Name	No. of distresses contribute, types of distresses		
	0-1Km	1-2Km	2-3Km
L057 to Ekauna	5(potholes, cracking, ravelling, rutting and edge break)	5(potholes,cracking,ravelling,rutting and edge break)	5(potholes,cracking,ravelling, rutting and edge break)
	3-4km	4-5km	5-6km
	5(potholes,cracking,ravelling,rutting and edge break)	5(potholes, cracking, ravelling, rutting and edge break)	5(potholes,cracking,ravelling, rutting and edge break)
T01 to TotaBigha	1 (ravelling)		
T02 to Behrawan	3(potholes, cracking, and edge break)		
Parsasampatchak road to Khusalpur school	5(potholes, cracking, ravelling, rutting and edge break)	5(potholes, cracking, ravelling, rutting and edge break)	5(potholes, cracking, ravelling, rutting and edge break)
Punpunmurhar road to Nawada	0-1Km	1-2Km	2-3Km
	1(Ravelling, 100%)	1(Ravelling, 100%)	1(Ravelling, 100%)
	3-4km	4-5km	5-6km
	1(potholes)	2(potholes, ravelling)	1(Ravelling)
PunpunNawada road to Paimar	5(potholes, cracking, ravelling, rutting and edge break)		
T02 to patanpura	0-1Km	1-2Km	
	1(Edge break)	2(potholes, edge break)	
T03 to Jolbigha	0-1Km	1-2Km	
	4(potholes,raveling, rutting and edge break)	5(potholes, cracking, ravelling, rutting and edge break)	
T02 to Dehri	0-1Km		1-2Km
	3(pothole, rutting and edge break)		1(potholes)
DumariGauwaspur to Chaitbara	0-1Km	1-2Km	2-3Km
	5(potholes, cracking, ravelling, rutting and edge break)	3(potholes, cracking and ravelling)	2(potholes,raveling)
T03 to Maranchi	3-4km		
	5(potholes, cracking, ravelling, rutting and edge break)		
	0-1Km	1-2Km	2-3Km
	1(Ravelling, 100%)	5(potholes, cracking, ravelling, rutting and edge break)	1(Ravelling, 100%)
	3-4km		
	1(Edge break)		
T06 to Chamuchak	3(potholes, cracking and edge break)		
Sohghi more PMGSY roads to sampatchak	0-1Km	1-2Km	2-3Km
	1(Ravelling, 100%)	1(Ravelling, 100%)	1(Ravelling, 100%)
	3-4km		
	3(potholes, ravelling, and edge break)		

RESULT AND DISCUSSION

Pavement conditions rating out of 37km rural roads are represented as 11% of the roads are in excellent condition,22% of the roads are in very good condition,13% roads are in good condition,16% roads are in fair condition,19% roads are in poor condition and 19% roads are in very poor condition as shown in Figure 6. Road wise condition along with age is described in Figure 8. Figure 7 also sows the contour of pavement condition index with age of the pavements. With the help of contour map we can observe the age of the pavement with its condition.

L057 to Ekauna roadwas 2 years 11 months 22 days old and condition of road was 66% poor and 34% fair. In this road 13% potholes, 21% cracking, 29% ravelling, 18% rutting and 19% edge break were observed. T01 to Tota Bigha roadwas 1 year 6 months 13 days old and condition of road was 100% excellent. In this road 1% ravelling was present only. T02 to Behrawan road was 6 years 5 months 19 days old and condition of road was 100% fair. In this road 10% potholes, 10% cracking and

80% ravelling were observed. Parsa Sampatchak road to Khusalpur School via Chipra Khurd road was 6 years 4 months 3 days old and condition of road was 67% poor and 33% fair. In this road 41% potholes, 7% cracking, 30% ravelling, 11% rutting and 11% edge cracking were present. Punpun Murhar road to Nawada roads was 3 years 5 months 13 days old and condition of road was 50% totally eroded i.e. fail and 50% are excellent condition. In this road 5% potholes and 1% ravelling were present. Punpun Nawada road to Paimar road was 6 years 5 months old and condition of road was 100% poor. In this road 18% potholes, 18% cracking, 41% raveling, 14% rutting and 14% edge cracking were present. T03 to Jolbigha road was 3 years 1 month 9 days old and condition of road was 100% fair. In this road 24% potholes, 3% cracking, 56% ravelling, 9% rutting and 9% edge break were present. T02 to patanpura road was 2 years 6 months 27 days old and condition of road was 50% excellent and 50% very good. In this road 17% potholes and 83% edge break are present. T02 to Dehri road was 2 years 7 months 25 days old and condition of road was 50% excellent and 50% very good. In this road 47% pothles, 47% raveling and 5% edge break was present. Dumari Gauwaspur to Chaitbara, road was 7years 9 months 15 days old and condition of road was 50% good, 25% very good and 25% excellent. In this road 37%potholes, 16% cracking, 18% raveling, 21% rutting and 8% edge break were present. T03 to Maranchi road was 6 years 10 months 15 days old and condition of road was 25% fail, 25% good, 25% fair and 25% excellent. In this road 25% potholes, 50% raveling, 10% rutting and 15% edge break were present. T06 to Chamuchak road was 1 year 5 months 26 days old and condition of road was 100% very good. In this road 5% pothole and 95% cracking were present. Sohghi more PMGSY roads was 5 years 9 months 24 days old and condition of road was 75% fail and 25% excellent. In these road 38% potholes, 46% ravelling and 15% edge break were present.

With reference to Figure 6, it has been observed that 67.57% roads have age around 4 years while 32.43% roads have age more than 4 years. About 35% roads are in serviceable condition whose condition is fair or above otherwise below fair condition. The rate of deterioration is very fast, this may be due to the bad quality of materials, degree of workability, and climatic condition of Patna, Bihar. In Bihar average annual rainfall is 1000mm/year and maximum temperature reached in summer is about 40 ^{o}C.

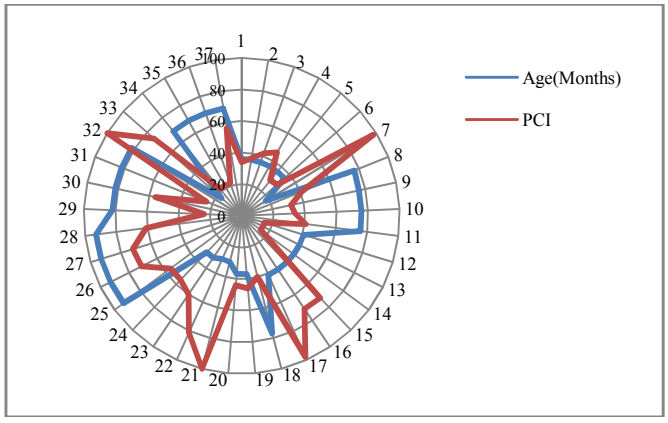

Figure 6 Cotour map for PCI and Age

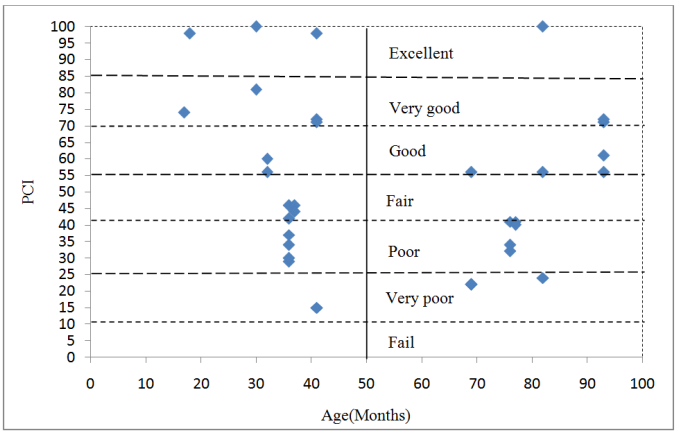

Figure 7 PCI versus age

CONCLUSION

Pavement condition survey was carried out on thirteen numbers of roads in Patna and per km road is considered for the assessment using PAVER method. Finally per km PCI is calculated and their rating is assigned. Combination of video graphic and image processing technique proved a cost effective, time saving and safe method for pavement condition assessment. Distresses like potholes and raveling is common to all the roads. It is found that 11%, 22%, 13%, 16%, 19% and 19% of 37kms roads length are in condition namely excellent, very good, good, fair, poor and very poor respectively.It may be noted that 67.57% roads have age around 4 years while 32.43% roads have age more than 4 years. Since, design life for rural roads is fifteen years but they may not in serviceable condition after four years. It means economic burden for treatment of such roads shall increase.

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