



IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: III Month of publication: March 2018 DOI: http://doi.org/10.22214/ijraset.2018.3710

www.ijraset.com

Call: 🛇 08813907089 🕴 E-mail ID: ijraset@gmail.com



Pavement Surface Distress Evaluation Using PCI

Pardeep Kumar Gupta¹, Parveen Atri² ^{1, 2} Civil Engineering Department, Punjab Engineering College, Chandigarh

Abstract: The aim of this paper is to evaluate the condition of the road performance for maintenance that occur due to surface distresses of various sections along the study area using Pavement Condition Index (PCI) concept. The study area along the Vidya Path and Vigyan Path in Chandigarh consisting of flexible pavement is selected to develop a Pavement Condition Index so as to assess the maintenance and rehabilitation needs. The PCI method was used as it is a distress based rating which evaluates the comprehensive visual condition of a road by categorizing different distresses and their severity. The mathematical expression for pavement condition index (PCI) provides an index reflecting the surface distresses which are the manifestations of pavement failure. The model for computing PCI is based upon the summation of deducts points for each type of observable distress. The paper involves extensive use of Google Earth Pro Software for drawing elements of Sections on Map and transferring the coordinates of sections to the field using GPS instrument. Surface distress and severity level data is acquired on the PCI inventory by visual field inspection on different sections. The weighted PCI of the different Sample Units along both the sections is calculated and subsequently results can be used for resurfacing/maintenance work on priority basis. Keywords: PCI, Section, Sample Unit, Maintenance, Distress, Chainage, Severity

I. INTRODUCTION

Road network plays an indispensable role in the achievement of government's overall social, economic, security, and developmental goals. Much capital has been expended in developing extensive road networks worldwide. To preserve the investment spent on this huge network of pavement, extensive maintenance and repair activities are necessary, with the intention of using funds optimally. With a large network of highways in place, a highway engineer's concern is shifted from construction to maintenance. To evaluate the maintenance requirements of pavement, distress based ratings, for example, PCI (Pavement Condition Index) is used to evaluate the comprehensive condition of a road by categorizing a pavement's surface distresses by type, frequency, and extent. Pavement condition is a generic phrase to describe the ability of a pavement to sustain a certain level of serviceability under given traffic loadings. PCI is a numerical rating of the surface condition of a pavement with 100 representing the best possible condition and 0 representing the worst possible condition of the road surface. The failure of a pavement may be defined as when PCI reaches a threshold (certain specified) value. PCI provides a tool on pavement performance for improvement of current pavement design and maintenance procedures. It is a statistical measure and requires manual survey of the pavement. PCI surveying processes and calculation methods have been standardized and for roads codal provisions of ASTM D6433-2011 has been used.

II. RESEARCH METHOD

The methodology involves the development of PCI Inventory as per ASTM D6433-2011 for data acquisition of distress survey. The study area of Chandigarh consisting of two sections namely Vidya Path having stretch of 7.2 km and Vigyan Path having stetch of 4.4 km were selected. Google Earth Pro Software was used for drawing elements of Sections on Map. Coordinates of sample units for different chainage were imported from the maps of both the sections and located on the site using GPS instrument. Distress and severity data is then acquired from the study area by visual inspection. Data collected is then analysed by assigning distress values and subsequently applying correction using Deduct Value Curves for Asphalt as per ASTM D6433-2011. Weighted PCI values of both the sections were then calculated.

A. Study Area

The study area chosen for carrying out the distress survey is located in the city of Chandigarh, India. Vidya Path having stretch of 7.2 km denoted as Section 1 and Vigyan Path having stretch of 4.4 km denoted as Section 2 were selected for carrying out the distress survey. The distress survey was carried out in the month of November, 2017 at both sections. Aerial View of Vidya Path selected has been shown in Fig.1 along with the marked location of the selected four Sample Units in Section 1.



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue III, March 2018- Available at www.ijraset.com



Fig. 1 Google Earth Aerial View of Section 1 (Vidya Path) using Google Earth Pro Software

B. Dividing Road Sections into different Sample Units

Both the road sections were divided into sample units after fixing the length of sample unit to a constant value of 200 m. The sample units were selected at random and spacing interval of fixed distance were calculated between the sample units. Table I enlists the basic details of both the sections where distress survey was carried out.

Road	Section Name	Section Length (km)	Sample Unit Length (m)	Number of Sample Units (N)	Number of Sample Units to be inspected (n)	Spacingintervalbetweentwosampleunits (i=N/n)
Vidya Path	1	7.2	200	36	4*	9 (1800 m)
Vigyan Path	2	4.4	200	22	4*	5.5 (1100 m)

Table I: Basic Details of Roads selected for Distress Survey

*As per ASTM D6433-2011 for sample units between 16 to 40

C. Marking Sample Units using Google Earth Pro

The sample units used for determining the PCI values in the sections are marked on the map using Google Earth Pro software. First of all road stretch of various sections were drawn on the map using Path Trace method. The length of various sections thus obtained were noted along with the requisite number of sample units to be surveyed. The stretch was thus divided into 'n' number of sample units. In both the sections, the number of sample units to be inspected comes out to be four in number. After choosing any random sample number the chainage of the first sample unit to be surveyed is to be drawn on the map using Path Trace method from the start point of the section. The area is then selected and marked on the map using different points. The coordinates at the start and end point of the sample unit are noted down for reference that is to be used on the site for carrying out the distress survey. Table II below shows the start and end points of sample units of both the sections.



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue III, March 2018- Available at www.ijraset.com

Chainage	Sample Unit 1		Sample Unit 2		Sample Unit 3		Sample Unit 4	
(m)	Start	End	Start	End	Start	End	Start	End
Section 1	600	800	2600	2800	4600	4800	5600	6800
Section 2	200	400	1500	1700	2800	3000	4100	4300

Table II: Chainage of Sample Units of Both Sections

D. Locating Sample Units Using GPS Instrument

The coordinates of the chainage of these sample units were observed form Google Earth Pro Software and then transferred to the ground using GPS Instrument. Table 3 below shows the coordinates of start and end points of sample units in Section 1.

<u>I</u>						
Sample Unit	Starting C	oordinate	Ending Coordinate			
1	30°45'48.33"N	76°47'19.53"E	30°45'43.07"N	76°47'23.93"E		
2	30°45'14.25"N	76°47'47.96"E	30°45'9.21"N	76°47'52.25"E		
3	30°44'40.60"N	76°48'16.22"E	30°44'35.32"N	76°48'20.61"E		
4	30°44'6.84"N	76°48'44.64"E	30°44'2.10"N	76°48'49.70"E		

Table III: Coordinates of End Points of Sample Units in Section 1

E. Visual Inspection

Inspection of each sample unit chosen individually is performed by walking over the sample unit length and carrying out visual distress survey to identify type, severity and quantity of distresses. Recording of the data as per ASTM D6433-2011 is done on the Condition Survey Data Sheet. An illustration of the data collected in Sample Unit 2 of Section 1 (Vidya Path) has been shown under:

ASPHALT	SURFACED	ROADS . SHE	AND PARKIN EET FOR SAM	IG LOTS IPLE UN	CONDITIO IT	N SURVE	Y DATA	SKETCH:			
BRANCH: SURVEYED	Vidya Path BY: Pa	uveen	SECTION DATE:	1	SAMPLE UN SAMPLE AR	IT: I EA:	II 2743				
 Alligator C Bleeding Block Crac Bumps and Corrugation 	racking king I Sags* 1		6. Depression 7. Edge Cracki 8. Joint Reflec 9. Lane/Should 10. Long and 7	ng* tion Cracl ler Drop (Frans Cra	king* Off* cking*		 Patching Polished Pothole Railroad Rutting 	g & Utility Cut 1 Aggregate s# 1 Crossing	 Shoving Slippag Swell Weather 	e Cracking ring/Ravelin	g
DISTRESS SEVERITY					QUANT	ITY			TOTAL	DENSITY %	DEDUCT VALUE
1L	4.32	7.92	4.86	2.88	5.94	2.16	23.4	8.1	59.58	2.17	17
1M	2.97	3.6	12.15	7.56	7.02	4.14	10	3	37.44	1.36	24
1H	0.94	à			a		5		0.94	0.03	0
2L	0.54	0.36			2		-	2	0.9	0.03	0
10L	3.9	1.8	2.7	4.5					12.9	0.47	0
10M	9	5.4	1.2	2.1	2.7				20.4	0.74	1
11L	1.98	48.96							50.94	1.86	4
	() ()								 1 5		
					86		19				
	3	2	5		3	2	2			10	3
								i i		Σ	46
Note: All mea	surements are	in square	meters except	* (meters) and # (numbe	ers)				PCI	54

Figure 2: Sample Data Sheet for Section 1 Sample Unit 2 for Distress Survey as per ASTM D6433-2011



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue III, March 2018- Available at www.ijraset.com

F. Calculation Of PCI

The weightages are assigned to all types of distress considering the severity levels and its extent. The deduct value graph for different type of distresses along with severity levels are used to find deduct values for different distresses. Subsequently corrected deduct values are obtained from the respective curves in ASTM D6433-2011 to find out the PCI values. The pavement condition index (PCI) is calculated using equation (1) as under:

$$PCI = 100 - CDV$$

Where: CDV = Corrected Deduct Value

Instead of using sample unit area calculation by multiplying road width with sample unit length, Google Earth Pro Software was used to determine the area of the sample units. The weighted PCI value of the section based on different sample units involved is calculated using equation 2 as under:

$$PCI_{S} = P\overline{CI_{r}} = \frac{\sum_{i=1}^{n} (PCI_{ri} \cdot A_{ri})}{\sum_{i=1}^{n} A_{ri}}$$
(2)

Where: PCI_r = Area Weighted PCI of randomly surveyed sample units,

 $PCI_{ri} = PCI$ of random sample unit i,

 A_{ri} = area of random sample unit i,

n = number of random sample units surveyed.

III.ANALYSIS AND RESULTS

The weighted PCI values of both the sections were computed based on the areas of different sample units as per equation (2) and are tabulated as:

Sample #	Sample Unit Area	Segment PCI				
	(m ²)	(0-100)				
1	2756	96				
2	2743	69				
3	2656	98				
4	3058	100				
Total Weigh	91					

Table IV: Weighted PCI Value of Section 1

	T La :4	A	Car			DCI	٦.
Table	V: We	eighted	PCI	Value	of	Section	2

(1)

Sample #	Sample Unit Area (m ²)	Segment PCI (0-100)
1	1938	62
2	2373	83
3	1967	96
4	1985	88
Total Weight Section 2	ted Average PCI for	82

IV.CONCLUSIONS

PCI Rating is pragmatic tool that can be used for maintenance requirements of road sections based on the capital to be spend. Maintenance is to be performed on the criteria of a threshold (certain specified) PCI value and those section whose PCI value is lower can be selected on priority basis than with the higher PCI value. The PCI rating of Section 1 (Vidya Path) was found out to be 91 whereas, the PCI rating of Section 2 (Vigyan Path) was found out to be 82. Based on the above result, Section 2 must be given priority over Section 1 for improvement of current pavement design or if maintenance/resurfacing work needs to be done.

V. ACKNOWLEDGMENT

I would first like to thank my thesis advisor Dr. Pardeep Kumar Gupta of the Civil Engineering Department at Punjab Engineering College, Chandigarh. The door to his office was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this paper to be my own work, but steered me in the right direction whenever he thought I



International Journal for Research in Applied Science & Engineering Technology (IJRASET)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887

Volume 6 Issue III, March 2018- Available at www.ijraset.com

needed it. Without his passionate participation and input, the extensive work used for research in the paper could not have been successfully conducted.

Finally, I must express my very profound gratitude to my parents for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this paper. This accomplishment would not have been possible without them.

REFERENCES

- [1] American Society of Testing and Materials (ASTM), ASTM D6433-2011, Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys; ASTM International: West Conshohocken, PA, USA; Available: http://www.astm.org [Accessed 20 September 2017].
- [2] Ary Setyawan, Jolis Nainggolan, Arif Budiart, 2015, "Predicting the remaining service life of road using pavement condition index." The 5th International Conference of Euro Asia Civil Engineering Forum, Vol. 125, pp 417-423.
- [3] Fareed M.A. Karim, Khaled Abdul Haleem Rubasi and Ali Abdo S, 2016, "The Road Pavement Condition Index (PCI) Evaluation and Maintenance: A Case Study of Yemen", Technology and Management in Construction Organization, Vol. 8, pp 1446-1455.
- Faris G. Faris and Mustafa D. Mahir, 2012, "Using of Modern GIS in Road Condition Index", Journal of Advanced Science and Engineering Research, Vol. 2, pp 178-190.
- [5] Giuseppe Loprencipe and Antonio Pantuso, 2017, "A Specified Procedure for Distress Identification and Assessment for Urban Road Surfaces Based on PCI" Available: http://www.mdpi.com/journal/coatings [Accessed 7 November 2017].
- [6] Kamalesh Panthi, 2009, "A Methodological Framework for Modeling Pavement Maintenance Costs for Projects with Performance-based Contracts", Florida International University, Miami, Florida.
- [7] Mubaraki M., 2013, "Identification of Pavement Distress Types and Pavement Condition Evaluation Based on Network Level Inspection for Jazan City Road Network". TJER, 11(1), Vol. 1123, pp 44-54.
- [8] Shahin, M. Y., Nunez, M. M., Broten, M. R., Carpenter, S. H., and Sameh, A. (1987). "New techniques for modeling pavement deterioration." Transportation Research Record, Washington, D.C, Vol. 1123, pp. 40-46.
- [9] Shah, Y.U; Jain, S.S.; Parida M., 2013, Development of Overall Pavement Condition Index for Urban Road Network. In Proceedings of 2nd Conference of Transportation Research Group of India (2nd CTRG), Agra, India; Volume104, pp. 332–341.
- [10] Walker, D.; Entine, L.; Kummer, S. Pavement Surface Evaluation and Rating: Paser Manual; Revised 2013; Wisconsin Transportation Information Center: Madison, WI, USA; Available: http://epdfiles.engr.wisc.edu/pdf_web_files/tic/manuals/Asphalt-PASER_02_rev13.pdf [Accessed 12 November 2017].
- [11] Witczak, M. W. and Bell, K. R. 1978, "Remaining life analysis of flexible pavements." Association of Asphalt Paving Technologies Proceeding, Minneapolis, Minnesota, Vol. 47, pp 229-269.
- [12] Sharma, Umesh and Abhishek, 2017, "Performance Evaluation of a Road in Chandigarh using Pavement Condition Index (PCI) Method." International Interdisciplinary Conference on Science Technology Engineering Management Pharmacy and Humanities, Singapore.











45.98



IMPACT FACTOR: 7.129







INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 🕓 (24*7 Support on Whatsapp)