

**PCI CALCULATION FOR DETERMINING MAINTENANCE STRATEGY
AN APPROACH FOR RAJKOT URBAN ROADS**

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Abstract: Road network is considered as the key factor for the development of any sector. With the increase in ownership of vehicle traffic is also increasing day by day this gradually increased axle load on road leads to many types of deterioration. So to keep existing road intact, maintenance becomes the important factors to be considered. Optimum analysis of highway maintenance includes the maintenance strategies that minimise the cost and enhancement of performance of pavement. Regularly maintained road lead to increase in the service life of road while on the other hand poor maintenance may cause accident, delay etc which directly or indirectly affects the economy. By the proper parameter Genetic algorithm will give the optimal solution from the selected pair.

Background:

With the rapid increase in urbanization the urban mobility increases which causes the increase of traffic in city. The study concern about the selected roads of Rajkot, Gujarat.

Rajkot is fourth major city of Gujarat and 35th largest urban agglomeration in India with population of 1.2 million (2015) with Population density 8500/km². Also it is 22nd fastest growing city in the world.

Objectives

- Structural evaluation of selected road stretches
- Functional evaluation of selected road stretches
- Calculation of PCI value
- Selection and implementation of formulation for the application .

1. Highway Maintenance

Crore of rupees being invested in the construction of road network and lots of year being taken for the completion of any road or transportation network project. Fault in road not only include the loss of money but it directly or indirectly affect the people’s benefits. It will increase delay, more travel time, discomfort etc. So to keep existing road intact, maintenance becomes the important factors to be considered. Regularly maintained road leads to increase in the service life of road.

2. Approach toward maintenance

After certain period of construction of road the deterioration of road started due to rapid growth of vehicle maintenance strategies are to be developed in order to optimize the available facility. i.e the maintenance strategy should be such that it include low cost and high performance of road.

3. Study Area

Selection of three different urban roads of Rajkot city is made. All these stretches has heavy traffic and have mix traffic composition. Inventory road data is as follows:

Description↓	Jamnagar – Rajkot highway(UR-01)	Kalawad road(UR-02)	Race Course road(UR-03)
Length Of stretch	1 K.M	1 K.M	1 K.M
Flow Direction	2 Way	2 Way	2 Way
No. Of Lane	4	4	4
Type of pavement surface	Bituminous	Bituminous	Bituminous
Type Of Road	Arterial	Sub-Arterial	Sub-Arterial

4. Types of data collected

- 1) Roughness data For functional evaluation (Using Bump integrator)
- 2) Deflection data for Structural Evaluation(Using Bencklemen Beam Deflection)
- 3) Distress data by visual inspection
- 4) Traffic Volume data

Roughness Measurement Using Bump Integrator

Roughness or unevenness is an important pavement characteristics because it affects riding quality of pavement. Roughness or unevenness data was carried out by Fifth Wheel Bump Integrator on selected stretches of road section. Bump Integrator shows no. of bumps present in the road on the selected section of roads. Unevenness Index was calculated based in the roughness data. The ratio of bumps count and the length travelled determines Unevenness Index which is measured in cm/km for given road sections. Unevenness Index was converted into International Roughness Index (IRI). (source: *Odaki and Kerali 2000*)
 $UI = 630 \times IRI^{1.12}$, Where, UI is unevenness index in mm/km.

	UR-01		UR-02		UR-03	
	LHS	RHS	LHS	RHS	LHS	RHS
UI(mm)	1220	1290	1330	1570	810	820
IRI	1.804127	1.896274	1.948687	2.25980	1.251556	1.265343
Avg IRI	1.850200606		2.104245023		1.258449747	

Structural Evaluation Of Pavements By Benkelman Beam

Performance of flexible pavements is closely related to the elastic deflection of pavement under the wheel loads. The deformation or elastic deflection under a given load depends upon sub grade soil type, its moisture content and compaction, the thickness and quality of pavement courses, drainage conditions, pavement surface temperature etc. Pavement deflection is measured by the Benkelman Beam which consists of a slender beam 3.66m long pivoted at a distance of 2.44m from the tip. By suitably placing the probe between the dual wheels of the loaded truck, it is possible to measure the rebound and residual deflections of the pavement structure. While the rebound deflection is one related to pavement performance, the residual deflection may be due to non-recoverable (IRC SP: 81-1997)

Distress Data

By the visual inspection of the selected stretches the distress data is collected. Cracked area and revealed area are measured in sq.m while pot holes in numbers and rut depth in mm.

Name of Road	Cracked area (m ²)	Revelled area(m ²)	Pot holes(no.)	Rutt depth(mm)
UR-01	1.56	1.24	9	1.2
UR-02	0.868	0.72	6	0.93
UR-03	0.512	0.32	1	0.12

Traffic Volume data

All the selected road stretch has some local attraction which made them busy and also they consist mix traffic.

Name of Road	PCU/hr	Max allowable PCU/hr
UR-01	3320.5	3600
UR-02	2621.9	2900
UR-03	3285.9	2900

From the data it can be concluded that the traffic is within the limit mentioned as per *IRC:106-1990*

➤ PCI calculation^[3]

- PCI(Pavement condition Index) is considered as the key factor for determining the condition of the road. After the calculation of distress data and using ASTM D 6433 the PCI is calculated by following steps.
- Inspect sample unit, determine distress type and severity level and then measure the density(%)
- The deduct values are determined from the deduct value curves for each distress type and severity.
- A total deduct value (TDV) is computed by summing all individual deduct values.
- Once the TDV is computed, the corrected deduct value (CDV) can be determined the correction curves. When determining the CDV, if any individual deduct.
- value is higher than the CDV, the CDV is set equal to the highest individual deduct value.
- The PCI is computed using the relation $PCI = 100 - CDV$.

➤ **From the PCI value the pavement id rated as per:**

PCI	Rating
85-100	Good
75-85	Satisfactory
55-75	Fair
40-55	Poor
25-40	Very Poor
10-25	Serious
0-10	Failed

In the case the PCI rating of selected stretches are as follows:

Name of Road	CDV (Corrected Deducted Value)	PCI(=100-CDV)	Rating
UR-01	60	40	Poor
UR-02	50	50	poor
UR-03	20	80	Satisfactory

5. Conclusion

As per IRC the growth rate of traffic in urban cities is consider as 7.5% but from the information collected from RTO(Regional Transportation Office of Rajkot) the traffic growth rate is nearly 10%.

It can be said that higher the PCI vaue of road better is the condition. From the analysis of the selected data and from the calculated PCI value it can be said that road UR-03 have less traffic and is in better condition as compared to other two. So the maintenance applied for that would be periodic maintenance. And for other UR-01 and UR-02 as the distress is there so there must be routine maintenance in order to increase the service life of highway as day by day the road will deteriorate.

References

- Amr A. Elhadid, Emad E. Elbeltagi, Mohammad A. Ammar(2015) "*Optimum analysis of pavement maintenance using multi-objective genetic algorithm*" Housing and building national research journal.
- 1) Ary Setyawana, Jolis Nainggolanb (2015) "*Predicting the remaining service life of road using pavement condition index*", science direct, procedia engineering 125(2015)
 - 2) ASTM D 6433 *international Standard Practice for Roads and Parking Lots Pavement Condition Index Survey*
 - 3) Dr Pardeep Kumar Gupta, Rajeev Kumar (2015) "*Development Of Optimum Maintenance & Rehabilitation Strategies For Urban Bituminous Concrete Surfaced Roads*", International Journal of scientific technology and research,vom-4,issue 02, Feb 2015
 - 4) *IRC 106-1990* " Code for the guidelines for the capacity of urban roads in plain terrain"
 - 5) *IRC: 81-1997* "Guidelines For Strengthening Of Flexible Road Pavements Using Benkelman Beam Deflection Technique"
 - 6) *IRC: 82-1982* " code for the guidelines for the maintenance of bituminous surface of highway"
 - 7) Magdi M.E. Zumrawi(2013) "*Survey and Evaluation of flexible Pavement Failures* """, International Journal of science and research, vol-4,issue-1 jan 2015
 - 8) Mr.etikala Nagaraju.(2015)"*Pavement Rehabilitation and Maintenance*", international journal of civil engineering,(SSRG-IJCE)-vol21,issue6-june2015
 - 9) Prof. Dr Fareed M.A. Karim,* Dr Khaled Abdul Haleem Rubasi, and Dr Ali Abdo Saleh. "*The Road Pavement Condition Index (PCI) Evaluation and Maintenance:A Case Study of Yemen*" Organization Technology and management in construction 2016;8:1446-1455
 - 10)Rokade S, Agarwal P K, Shrivastava R. , "Study on performance of flexible highway pavements," *International Journal of Advanced Engineering Technology*, vol. 1, no. 3, pp. 312-338, 2010.
 - 11)Yogesh U. Shah, S.S. Jain. Devesh Tiwari, M.K. Jain(2013)"*Dvelopment of Overall Pavement Condition Index For Urban Road Network*" Science Direct- Social and Behavioral sciences.