Performance Evaluation of Pavements: A Case Study on Kankot –Mavdi Road

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Abstract— at present road users increasing due to escalating growth of socio-economic activities which impacts on the services qualities of transport corridor. It has become disquieting facts for all the developing regions. Inhabitants are the victims of this, it can be further evaluate by measuring detrimental effects in contexts of functional and structural behaviors of pavement by like crack, pot holes, rut etc. Present paper emphasis on performance evaluation of Kankot-Mavdi road in Rajkot by supplementing research with the use of performance indicator instruments like MERLIN, BBD.
Key words: Merlin, BBD

I. Introduction

Transportation infrastructure plays a lead role in economic growth and development of country. Pavement are one of the most important part of any transportation system. There is need for efficient and effective management and maintenance. Flexible pavements undergo functional deterioration as well as structural deterioration simultaneously due to the combine effects of climate, environment and traffic loads. Due to heavy traffic load of commercial vehicles, all the components of the pavement surface get disturbed and distress. The functional deterioration is indicated by the changes in surface condition of the pavement in the form of deterioration in the riding quality, which can be measured by simple methods; it is also possible to restore the surface to original condition of the pavement by providing a profile correction course and a resurfacing layer.

The rate of structural deterioration of flexible pavement depends on several factors such as (a) the stability of the existing Pavement structure and the component layers (b) magnitude and reoperation of traffic wheel loads (c) growth rate of traffic loads (d) effective functioning of pavement drainage system and severity of the climatic and environment factors.

Quality of the road surface, stiffness and thickness of pavement layers are important parameters which influences the performance and efficiency of roads. Pavement evaluation of existing roads and quality control of new roads.

The aim of the research has been functional evaluation visual observed by measuring cracking, rutting, patching, revelling etc. in deterioration pavement. In structural evaluation of existing flexible pavement by Benkelman beam method and find out deflection of pavement. Then after calculate the thickness of overlay of flexible pavement as per IS standard.

II. Need of Study

Good road management is necessary and maintenance and rehabilitation actions must be taken with good timing. Safe and comfortable movement of traffic.

Major economic losses will continue unless improve capabilities for rehabilitation design are provided to meet today's highway traffic needs, as most projects today include rehabilitation design.

III. Objectives

- Carry out the present pavement condition. And traffic volume.
- To evaluate the structural condition of pavement by using BBD test.
- To carry out soil sample and testing.
- To calculate the thickness of overlay layer pavement.

IV. Methodology

The detailed step by step procedure of performance of pavements is described below

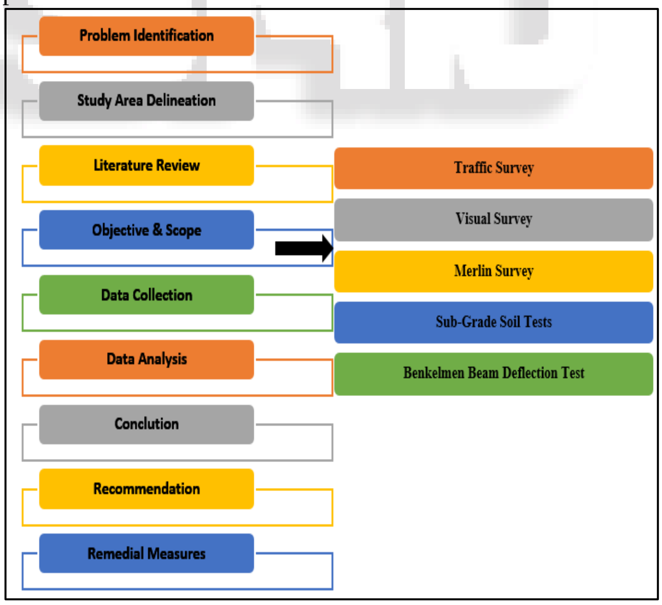

Fig. 1: Step by step procedure of performance of pavements

A. Pavement performance data

1) Visual Survey Data

The functional evaluation survey is conducted on Kankot-Mavdi Road 7 km length of flexible pavement. In this phase of operation, visual observations supplemented by simple measurements for Rut-depth, block crack, patching, alligator crack, longitudinal crack, transverse cracks, and pot holes etc. distress using a 3 m straight edge (Table 1). As it is inexpedient to modify the overlay design at frequent intervals, it will be preferable if the length of each section of equal performance in accordance with the IRC 82: 2015 criteria.

Fig. 2: Visual Survey

Sr. no	Cracks in m^2	Patching in m^2	Pot holes in m^2	Reveling in m^2	Pavement classification section
1	559.2	377.1	123.4	750.12	POOR
2	5.93	27.28	12.57	0.00	FAIR
3	5.04	4.19	6.49	0.00	FAIR
4	204.6	353.2	67.36	745.44	POOR
5	65.13	355.7	88.21	1086.9	POOR
6	6.58	386.3	154.5	1497.2	POOR
7	62.04	374.6	37.10	1689.2	POOR

Table: 1 Distress Measurement during Visual Condition Survey

B. Pavement Surface Roughness Measurements

Fig. 3: Merlin used on Field

The roughness of existing pavement is assessed in terms of roughness index in mm/km as per the procedure given in IRC: SP: 16. MERLIN [Machine For Evaluating Roughness Using Low-Cost Instrumentation] can be used either for direct measurement or for calibrating response-type instruments such as the vehicle- mounted bump integrator. It consists of a metal frame 1.8 m long with a wheel at the front, a foot at the rear, and a probe midway between them that rests on the road surface. The probe is attached to a moving arm at the other end of which is a pointer that moves over a chart. The machine is placed at successive locations along the road and the positions of the pointer are recorded on the chart to build up a histogram. The width of this histogram can be used to give a good estimate of roughness in terms of International Roughness Index.

C. Present Calculation Serviceability Index

Present serviceability index concept developed during AASHO-Road Test .A present serviceability index was then developed for estimating the subjective ratings from objective measurements taken on the pavement,

One of the major contributions of the AASHO Road Test was the development of a rating system involving the measurement of permanent deformation, riding quality and extent of cracking and patching. The rating is well-known by the term. Present serviceability index (PSI) and is probably the most widely used pavement rating measure in existence today. The following equation was developed to determine the level of serviceability of flexible pavement sections on the AASHO Road Test:

$$PSI = 5.03 - 1.91 \log (1+SV) - 0.01\sqrt{(C+P)} - 1.38\, RD^2$$

Where: P = the present serviceability index.

SV = the mean of the slope variance.

RD = Rut Depth under a 3 ft. straight edge.

C = Cracking distress in terms of lineal feet of cracks per 1000 sq. ft. area.

P = Patched area in terms of lineal feet of cracks per 1000 sq. ft. area.

Chainage	Type of Surface	Condition of Surface Roughness		
		Good <2500	Average 2500-3500	Poor >3500
0.00 to 1.00	Semi-Dense Bituminous Concrete			4154.1
1.00 to 2.00			2686.3	
2.00 to 3.00		2197.12		
3.00 to 4.00				4646.37
4.00 to 5.00				3909.5
5.00 to 6.00				4888
6.00 to 7.00				4398.75
Total		1	1	5

Table 2: Calculation of Roughness

1 (km)	2 (Ft²)	3 (Ft²)	4 (inch)	Present Serviceability Index (PSI)		
CHAINAGE	Avg. Cracks in 1000 feet² (Ft²) (C)	Avg. Patched in 1000	Average Rut depth	(IRI)	PSI	Condition

0.00 to 1.00	79.88	53.8	0.47	5.6	1.03	Poor
1.00 to 2.00	0.8457	3.85	0.00	4.2	2.00	Fair
2.00 to 3.00	0.72	0.55	0.00	3.7	2.12	Fair
3.00 to 4.00	29.23	50.4	0.51	6.7	0.73	Poor
4.00 to 5.00	9.3	50.6	0.39	5.4	1.23	Poor
5.00 to 6.00	0.9413	55.8	0.64	6.4	0.61	Poor
6.00 to 7.00	0.8232	47.5	0.60	5.9	0.81	Poor

Table 3: Calculation of PSI

D. *Structural Evaluation of Pavement by Benkelman Beam*

For measuring the structural condition of road, Benkelman Beam Deflection Method which is used to measure rebound deflection of pavement would be used. It is most commonly used instrument which is simple and cheap.

Rebound Deflections were evaluated as per the guidelines given in the IRC 81 – 1997 for measuring the results and carrying the survey for measuring deflections. Characteristic primary, secondary and urban roads, 2004 Deflection based on the statistical analysis of actual deflections are calculated as per the IRC 81 -1997 guidelines.

The result obtained from the Benkelman Beam survey had been shown in the table below. It shows the characteristic deflection of the pavement on given sections in both directions. Deflection.

Sr. No	Chainage (Km)	Deflection (Mm)
1	0.00 to 1.00	1.70
2	1.00 to 2.00	-
3	2.00 to 3.00	-
4	3.00 to 4.00	1.71
5	4.00 to 5.00	1.66
6	5.00 to 6.00	1.64
7	6.00 to 7.00	1.72

Table 4: Calculation for Rebound Deflection and Characteristics Deflection

E. *Soil Sampling and Testing*

Soil sample has been collected from poor surface condition by anger technique calculation of LL, PL, and PI Of all samples and results of all the sample are as given below in chart:

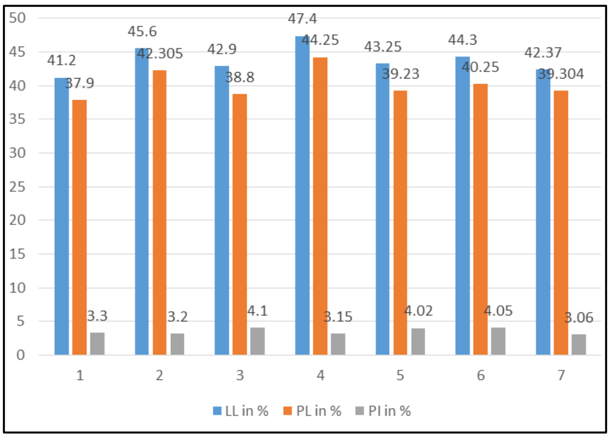

Fig. 4: Soil sample

F. *Traffic Survey of Commercial Vehicle per Day (CVPD) for Calculation of Design of Traffic*

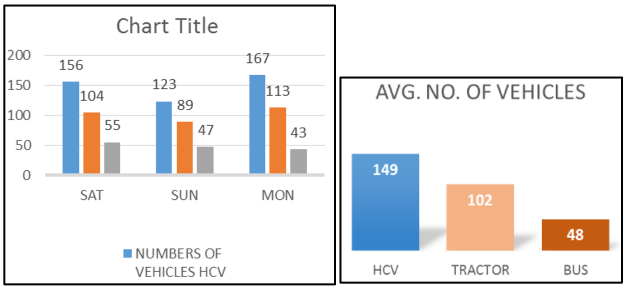

Fig. 5: Traffic Survey of Commercial Vehicle per Day (CVPD) for Calculation of Design of Traffic

The commercial traffic 396 CV/ day has been reported on the stretch. The design traffic calculations for overlay design.

1) *Calculation of million standard axel*

Initial traffic on the stretch = 396 CV/ day

A= initial traffic x lane distribution factor,

Lane distribution factor = 0.5 (as per IRC: 37-2012 for two lane single Carriage way roads).

Hence,

A = 396 x 0.5 = 198,

r = 7.5 % (assumed growth rate, as per IRC: 37-2012

x= 10 years as per IRC: 37-2012

F= 3.5 for plain roads carrying traffic 0 to 1500 CV/day

$$Ns = \frac{365 * 198\,[\{1+0.075\}^{10}-1]}{0.075} * 3.5$$

Ns. ≈ 3.578 msa

2) *Overlay Thickness Design*

From the result of Benkelman beam deflection survey the average characteristic deflection is 1.686 mm and design traffic is 35.782 msa. The overlay design is:

115 mm BM from IRC: 81-1997 Chart.

V. CONCLUSION

The visual observation for cracks, potholes and revelling can explain weak spots of pavements.

The Benkelman beam study was conducted on all the section of Kankot–Mavdi road and inadequacies were found in all the sections.

There is a need to go for measures such as an overlay on all the sections of Kankot-Mavdi road. The overlay thickness in terms of bituminous concrete were found for all the stretches.

The visual observation and Benkelman beam deflection correlate each other.

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