Pavement Management System on Urban Road Network

Manikanta Itta, K. Jaya sunder

***Abstract*— Pavements are major assets of Urban infra structure. Maintenance and rehabilitation of these pavements to the desired level of serviceability is one of the challenging problems faced by pavement engineers. The evaluation of pavement performance using pavement condition is a basic component of any Pavement Management system. (PMS) is a planning tool used to aid pavement management decisions, pavement deterioration due to traffic and weather, and recommend maintenance and repairs to the road's pavement based on the type and age of the pavement and various measures of existing pavement quality. The present paper is an effort in the similar direction, to develop a combined Overall pavement Condition Rating (OPCR) for the selected network of Hyderabad City Roads.**

The study area consists of urban road sections constituting 39.9 km of Hyderabad city. The methodology includes the identification of urban road sections, pavement distress data collection, Pavement condition Distress, Quality control analysis and finally developing Overall Pavement Condition Ratings (OPCR). The proposed rating is expected to be a good indicative of pavement condition and performance. The Ratings was used to select the maintenance strategy for the pavement section., please download TEMPLATE HELP FILE from the website.

***Index Terms*—Pavement Management, Pavement Management system**

I. INTRODUCTION

All the individual condition indices and the combined index ranged from the value 0 to 100. The pavement condition was rated based on these values as 0-10: Failed; 10-25: Very Poor; 25-45: Poor; 40-55: Fair; 55-70: Good; 70-85: Very Good; 85-100: Excellent.

II. NEED FOR THE STUDY

Due to the large scale industrialization and commercial activities, there has been an unprecedented traffic growth during the last four decades in Hyderabad city.

The Road User Cost Study in India has established that due to improper maintenance and poor surface condition of road pavements, there is a considerable economic loss to the country due to increase in vehicle operation costs. If the road pavements are maintained to the desired level at an appropriate time, it is possible to save the losses in road user cost.

The whole life cycle cost analysis based on the road user cost relationships enables the decision makers to examine financial and economic implications of various options for formulating appropriate strategies for cost effective use of resources.

III. OBJECTIVE OF THE STUDY

The aim of this study is to suggest establishment of a new system of pavement management in Hyderabad City. The basic purpose of pavement management system is to achieve best value possible for the available public funds and to provide safe, comfortable and economic transportation. The function of management at all levels involves comparing alternatives, coordinating activities, making decisions and seeing that they are implemented in an efficient and economical manner.

The intent of this report is to present the development of a PMS for use with Hyderabad city roads in the state of Telangana.

IV. STUDY AREA

In this some stretches are selected and field trips were done in main places of Hyderabad. In which LB Nagar to MGBS, Abids to Nampally, Khairathabad to Ameerpet, Balanagar to Bhadurpalli, LB Nagar to Sec-bad.

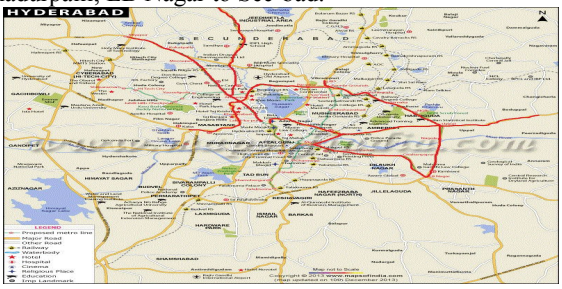

Figure 1: Hyderabad selected road network

Upon which Khairathabad to Ameerpet stretch is selected for detail survey it is a 4.5km stretch of two lane carriageway and ofvarying width.

Figure 2: selected stretch Ameerpet to Khairathabad

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Manikanta Itta, Transportation Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

K. Jaya sunder, Asst. professor, M.Tech- Transportation Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

V. FIELD STUDIES AND DATA COLLECTION

Following data were collected from field studies.

A. Road Inventory surveys
B. Visual Survey &Distress Evaluation
C. Maintenance Priority Index (MPI)
D. Pavement Excavation
E. Traffic surveys

A. Road Inventory Surveys

The roadway inventory is the foundation of any pavement management system; since it supports the other system components and provides the information those components will need to function. The basic purpose of the inventory is to provide information describing the pavements physical features. Certain basic information must be known about each roadway in the inventory. The minimum required data for each street segment includes:

- Data entry date or construction year (last surface).
- Street name, number and segment designation.
- Beginning and ending location of the segment.
- Functional classification.
- Number of lanes.
- Pavement type.
- Pavement thickness.
- Pavement length, width and area of the segment.
- Average Daily Traffic (ADT).

This data does not change with time until major work, such as reconstruction or realignment of the road is carried. Therefore this data has to be collected only once.

A good inventory may require a computer system. A computer can quickly and easily manipulate large amount of data and may be desirable in many cases. An inventory can be recalled and used easily for making sound management decisions.

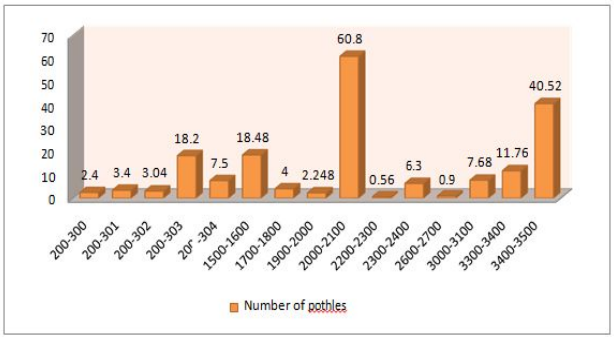
Road Inventory surveys are conducted on various roads. The results of road Inventory data are shown in table 1.

Table 1: Road Inventory survey details

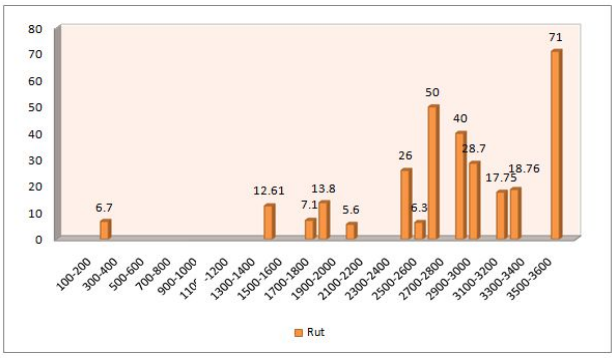
Place	Carriage way Width		Shoulder Width		Median Width
	L.H.S. In meters	R.H.S. In meters	L.H.S. In meters	R.H.S. In meters	In meters
Ameerpet signal	12.3	10.62	0.22	0.33	0.5
Punjagutta-TOD	11.71	11.69	0.18	0.27	0.5
Irrumanzil-TOD	8.1	8.72	0.1	0.22	0.5
Khairathabad-signal	14.81	15.7	0.31	0.27	0.5

B. Visual Survey & Distress Evaluation

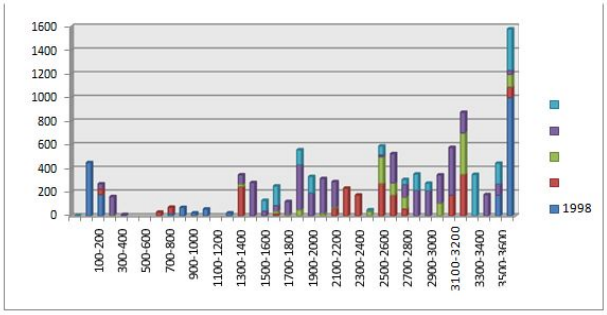
Visual survey done for selected stretches and major stretch to evaluate the data, Severity found in much extent.The Greater Hyderabad Municipal Corporation under takes the M&R works for the entire Hyderabad City which includes National Highways passing through the city.



Graph 1: Shows Number potholes vs chain age-PCI



Graph: Shows the Rutting length of Rut Vs Chainage-PCI



Graph 2: Shows the Area of raveling of different severity levels vs Chainage-PCI

C. Maintenance Priority Index (MPI)

A simplified procedure for determining the maintenance priorities of industrial road at network level are suggested in this study. The study aims at developing a structured approach to evaluate and prioritize industrial road sections in the existing industrial road network, which will help in making efficient use of the available limited maintenance budgetary provisions. There are number of factors that influence the performance of industrial roads. Five factors namely cracking, raveling, rutting, pot-holes and edge-breaking are considered for suggesting maintenance index for industrial roads.

This is the final index indicating the overall priority associated with the industrial road link. MPI is defined as follows:

MPI=RCI* RUF

RCI = Road condition Index

RUF = Road user factor

Road condition Index (RCI) = $\frac{\sum(ui \cdot wi)}{\sum wi}$

Where UI =Urgency Index
Wi = Weightages

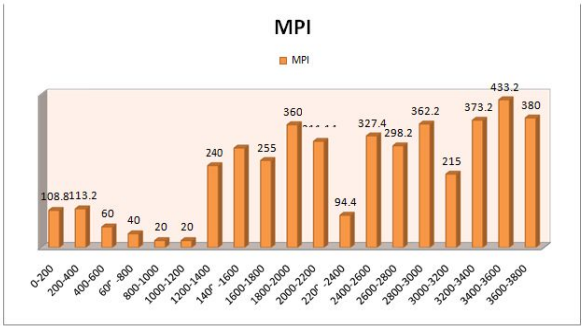
Urgency Index (UI) gives indication of the road condition, i.e. higher the value of UI means the road is badly affected by that factor and urgent attention is required.
All the five factors do not influence the road condition equally. Hence to take into account their individual effects different weights are assigned to each factor. The values for weightage range from 1to5. These relative Weightages for different factors are decided based on the field survey and discussion with the actual users of the industrial roads.

Road User Factor (RUF) = (TV *TC)

Where TV = Traffic Volume and
TC = Traffic Composition

The priority given for the maintenance of the industrial roads doesn't depend only on the condition of the road. It also depends on number and type of vehicles using the road. Hence two parameters TV and TC are incorporated into the model.
TV indicates the number of vehicles passing on the particular link in a day.

Higher value of MPI suggests that the industrial road link is in bad condition and should be given higher maintenance priority while considering the network for maintenance.



Graph 3: Chainage vs MPI

D. Pavement Excavation

The compositions of pavement layers are found through pavement excavation.

Fig 3: Pavement excavation showing layers

NH9 passes through Hyderabad, at some selected stretches from LB Nagar to MGBS Excavation done to find out the depth of bituminous layers and found equivalent as per IRC:37-2001.

Figure4: Cross section of selected stretch

Of same NH9 stretch passing through Khairathabad to Ameerpet, No layers found up on excavation only bituminous overlays found up to 450mm and beneath that CC road found casted 20-25 years before at selected stretch. The same criteria found at Abids to Nampally stretch upon excavation.
Traffic Surveys and Quality control analysis done to find out the severity to cause distress for design failure or of quality lag.

E. Traffic Surveys

Traffic surveys are conducted to determine various parameters for the Distress of pavements at regular intervals.

A. Average Daily Traffic (ADT)
B. Passenger Car Units (PCU)

A. Average Daily Traffic (ADT)

Average daily traffic (ADT) counts represent a 24-hour count at any specified location. Accuracy of the ADT data depends on the count being performed during typical roadway, weather, and traffic demand conditions. Local levels of government will typically conduct this type of count.The traffic data collected during field surveys have been compiled and converted into equivalent passenger car units (PCU) to determine the average daily traffic (ADT) in vehicles and in PCUs.

Average daily traffic (ADT) is presented in vehicles/day as well as in PCUs/day. This helps in deciding the relative importance of a route and in phasing the road development program.

The ADT of selected stretch are shown in Annexure 1.

B. Passenger car units (PCU)

Different classes of vehicles such as cars, vans, buses, trucks, auto-rickshaw, motor cycles, pedal cycles, bullock carts, etc. are found to use the common roadway facilities without segregation on most of the roads in developing countries like India. It is common to consider passenger car as the standard vehicle unit to convert the other vehicle classes and this unit is called Passenger Car Unit (PCU).

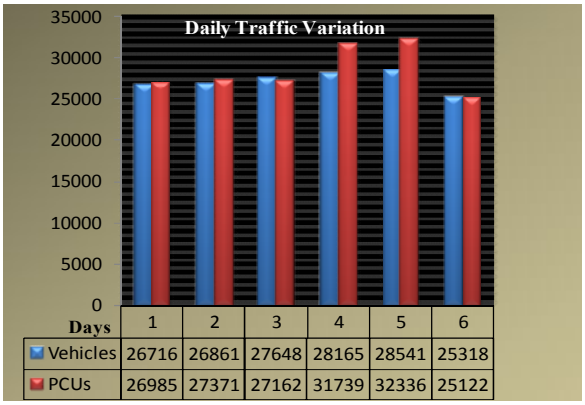


Figure 5: Daily traffic variation

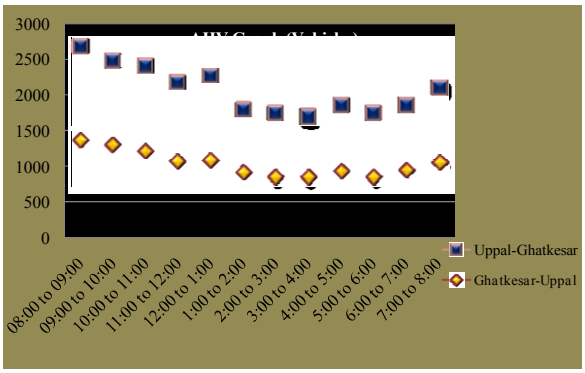


Figure 6: Average Hourly Volume Traffic

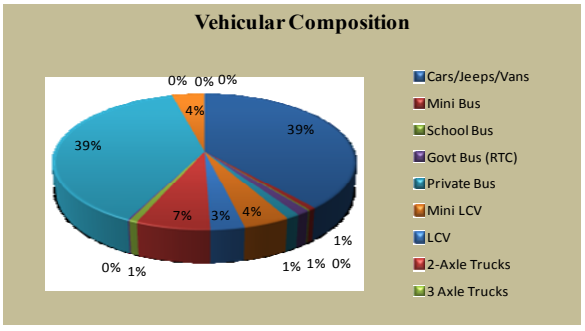


Figure 7: Vehicular composition

VI. QUALITY CONTROL SYSTEM

Quality control analysis is applied to the sample of laid bituminous layer.

A. Grading Requirement for Dense bituminous macadam (DBM)

At the present time the dense flexible macadam (DBM) is specified for use as a base course and/or binder course.
Two gradations of the DBM are specified in Section 507 of MORTH specifications: Grading 1 has a NMAS of 37.5 mm and Grading 2 has a NMAS of 25 mm.

When a sample is extracted from existing DBM layer, it shall satisfy the requirements of Annexure2 when tested for bitumen content and followed by sieve analysis.

B. Grading Requirements for Bitumen concrete (BC)

Bitumen concrete is of two types. Type- I and Type-II with nominal size aggregates as 26.5mm and 19mm respectively results of selected grade are shown in Annexure 3
Sieve analysis is carried out on this aggregate sample, i.e. 570.6gm. The sample is not found to be satisfying the requirements as per MORTH.
The results obtained for bitumen content test is 4.4%
But as per MORTH 5th Revision DBM grading-II is Min.4.5%

C. Overall Pavement Condition Index (OPCI)/ Rating

The Overall pavement Condition Index/ Rating is a numerical Index ranges from 0 to 100 which is used to indicate the general condition of the pavement.
The following table indicates the OPCI values and suggested Maintenance Alternative for the pavements in the stretch.

Table 2: Overall pavement Condition Index/Rating

Stretch	OPCI/ Rating	M&R Strategy	Suggested Maintenance Alternative
Ameerpet-Khairathabad	40 (poor)	Reconstruction	Cold in place recycling full depth reconstruction
Balanagar-Bahadurpally	10 (Failed)		
LB Nagar-Secunderabad	60 (good)	Rehabilitation	Full depth Reclamation Thick overlays Mill, Full depth Patching premix concept
Abids – Nampally	55 (Fair)		
LB Nagar-MGBS	50 (Fair)		

CONCLUSIONS

- The minimum and maximum range of various pavement performance indicators are observed on the study sections are: longitudinal cracking: 8.3% &11.86%; transverse cracking: 2.23% & 6.61%; alligator cracking: 11.44% &16.16%; patching: 4378% &12.0%, Raveling: 9.58% &29.24%, Deflection: 1mm to1.82mm.
- Based on the survey Maintenance of pavements is not done regularly, overlays of pavements are going on without testing (i.e. Deflection testing). Continuous Overlays are done without reconstruction of Stretch.
- Quality reveals that Quality of materials also not up to the mark. Traffic growth is in high rate while design of overlays is not considering.
- Due to growth of traffic is more considerations are taking into account for overlays. Thickness of Overlays also neglected.
- For Stretch One OPCI/R Reconstruction should do, if not maintenance cost will be too high.
- Width of the road is also varying from place to place due to this vehicular load is more at particular stretch and causes deterioration, due to improper drainage

facility water get staged on roads and causes damage to roads, In rainy seasons its effect is severe.

- Pavement structural strength was found to be a crucial pavement condition indicator for changing the pavement performance and deciding the M&R strategy for selected urban pavement sections.

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Annexure 1

Summary of ADT

Mode	Traffic Composition (ADT) (Vehicles)			Traffic Composition (ADT) (PCUs)		
	SR Nagar – Khairathabad	Khairathabad - SR Nagar	Total	SR Nagar - Khairathabad	Khairathabad - SR Nagar	Total
Cars/Jeeps/ Vans	8561	7053	15614	6310	6978	13288
Mini Bus	231	145	376	152	149	301
School Bus	46	53	99	87	91	178
Govt. Bus (RTC)	322	241	563	552	548	1100
Private Bus	201	189	390	576	566	1142
Mini LCV	259	301	560	654	636	1290
LCV	281	169	450	305	342	647
2-Axle Trucks	563	532	1095	3153	3178	6331
3 Axle Trucks	86	94	180	357	370	727
4-6 Axle Trucks	19	21	40	108	116	224
2-W	7783	6534	14317	4210	4502	8712
Auto Rickshaws	842	871	1713	879	912	1791
Cycles	3	4	7	2	2	3
Cycle Rickshaws	1	2	3	2	3	5
Animal Drawn	0	0	0	0	3	3
Total Traffic	**19198**	**16213**	**35307**	**17347**	**18396**	**35742**

Annexure 2

Grading	I	II
Lift Thickness	80-100 mm	50-75 mm
Nominal Aggregate Size	40 mm	25mm
Sieve, mm	Per cent Passing	
45	100	
37.5	95-100	100
26.5	63-93	90-100
19	-	71-95
13.2	55-75	56-80
9.5	-	-
4.75	38-54	38-54

2.36	28-42	28-42
1.18	-	-
0.6	-	-
0.3	7-21	7-21
0.15	-	-
0.075	2-8	2-8
Bitumen Content, %	**Min. 4.0**	**Min. 4.5**

Annexure 3

Grading	**1**	**II**
Lift Thickness	50-65 mm	30-45 mm
Nominal Aggregate Size	26.5 mm	19 mm
Sieve, mm	Per cent Passing	
26.5	100	--
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	42-58
0.60	15-27	26-38
0.30	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen Content %	**5.0-6.0**	**5.0-7.0**

Author Details

Manikanta Itte was born on 1st August 1991 in Kadapa Dist,A.P. He has completed his Bachelor of Civil Engineering from Tudi Narashima Reddy Institute of Science and Technology, Bibinagar, Hyderabad in 2012. Currently he is pursuing his M.Tech (Transportation Engineering) from Malla Reddy Engineering College, Dhulapally, Medchal, Hyderabad.

K. Jaya sunder was born on 26th of August 1991. He has completed his Bachelor of Civil Engineering from Bapatla Engineering College, Bapatla in the year 2012 and completed M.Tech (Transportation Engineering) from Visvesvaraya National institute of Technology, Nagpur. Currently he is working as Asst. professor in Malla Reddy Engineering College, Dhulapally, Medchal, Hyderabad.