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Study & Analysis of Preventive Maintenance Practices of Flexible Pavements Using Pavement Management Systems

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ABSTRACT : *Pavement Management Systems (PMS) are widely used to maintain safe, durable and economic road networks. Pavement gets damaged due to environment effect and traffic movement, maintenance, therefore essential for the safety of the passengers as well as vehicles. Pavement Management System is the process of planning and maintaining, repair of a network of roadways .It must be cost effective from the life cycle point of view.*

In this study, historical data & current data of pavement distress and pavement conditions, on the project road State Highway (SH-93) Wakan to Khopoli section (Km. 0 to Km. 41) for 10 km road section (Km 41 to Km 31), were collected. This section starts from the Khopoli junction where there is a T-junction formed with Pen-Khopoli road and the Wakan- Khopoli road. This junction is adjacent to the Mumbai – Pune expressway which can be accessed from this road. The data collected was categorized, processed, and analyzed, is used to generate prediction of pavement distress and condition models.

Keywords: *Historical data, pavement distress, condition model, predictions, current data.*

I. INTRODUCTION

All Highway facilities get damaged as time goes by, an appropriate maintenance is required for a road to provide the optimum service. Highway facilities, pavement is directly contacted by the vehicles, affects the passenger's comfort, and damage to the vehicles and consumption of energy. As pavement gets damaged due to the traffic and the environmental effect, the road management institution performs timely maintenance activities within the limit of the budget to maintain the pavement in good state. Cost of maintenance increases every year due to increase in raw material prices. We need the basis to make a decision, and to use the limited budget in an efficient manner.

The cost for maintenance also increases due to increase of labor cost. We cannot depend on individuals' experience and sense in determining the budget. We required the basis to make a decision, and to use the limited budget in an efficient manner. To tackle the situation, road managers are required to manage the road facilities in a more systematic method than before, and therefore standard & systematic method is required to fulfill the requirements through various types of surveys, analysis and estimation.

The Pavement Management System is a set of tools or methods that can assist decision makers in finding cost effective strategies for evaluating, providing, and maintaining pavements in a serviceable condition. It provides the necessary information to make these decisions. The PMS consists of two basic components: A compact database, which contains historical and current information on pavement condition, pavement structure, and traffic. The second component is a set of tools that allows us to determine existing and future pavement conditions, predict financial needs, and identify and prioritize pavement preservation projects.

1.1Typical tasks performed by pavement management system include:

- To perform Inventory of pavement conditions: identifying good, fair and poor pavements.
- To assign importance ratings for road segments based on traffic volumes, road functional class, and community demand.
- To Schedule maintenance of roads to keep them in better condition.
- To Schedule repairs of poor and fair pavements on priority basis.

1.2Pavement Condition Index:

Table I: Pavement Condition Index

CONDITION CATEGORY	PAVEMENT CONDITION INDEX(PCI)		GENERAL TREATMENTS TRATEGY
	Upper limit	Lower limit	
Excellent	100	86	Do nothing/Corrective Maintenances
Good	85	75	Preventative Maintenances
Fair	74	58	Resurface
Poor	57	40	Rehabilitation
Failed	39	0	Reconstruction

II. OBJECTIVE

- The main goal of this study paper is,
- Enhanced safety and raise the level of service for the road users;
- To prioritise operation and maintenance activities enabling enhancement of operational efficiency of the Project;
- To minimize adverse impact of repairs/ reconstruction of road the local population and road users.
- To minimize adverse impact on environment.
- Acquiring optimum solution of road maintenance using pavement management system.

III. METHODOLOGY

Pavement management system for flexible pavement is very important for the optimum use of the road by the user as well as keeping the condition of road in good state, so that cost incurred for the maintenance is less.

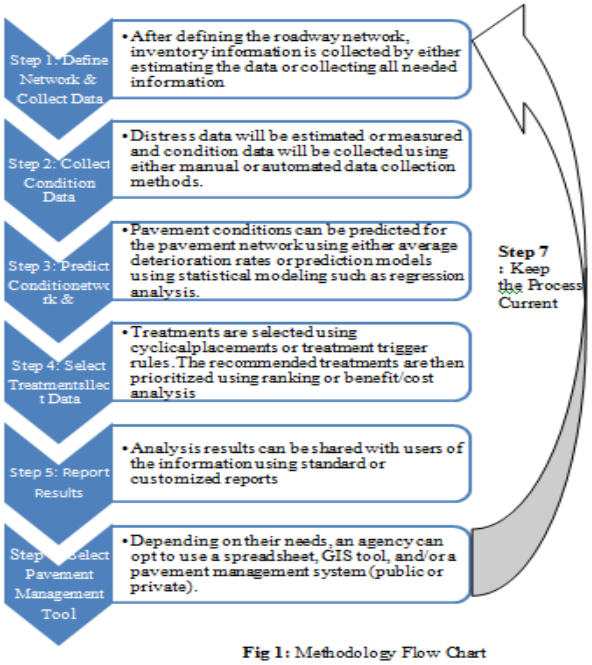

Fig 1: Methodology Flow Chart

IV. ANALYSIS

4.1. Project Background :

The project road from Wakan to Khopoli is section (Km. 0 to Km. 41) of State Highway (SH-93). For present study purpose 10Km road from Khopoli towards Wakan (Km 41 to Km 31) is considered. This section starts from the Khopoli junction where there is a T-junction formed with Pen-Khopoli road and the Wakan- Khopoli road. This 'T ' junction is adjacent to the Mumbai – Pune expressway which can be accessed from this road. On enquiry with the concern department it is learnt that departmental procedure for filling pot holes has remained same in the 5 years. The process is to fill pot holes with metal and broken bricks during heavy monsoon period

and dry macadam filling after rainy season. This clarifies that no major repairs have been under taken in past 5 years. Hence this analysis will help to find solutions of better results.

Table No II : Soil Testing

Project /Site	**: Road Nh From Wakan-Pali-Khopoli Road (Sh-93 From Km. 31/000 To 36/000)**										
Chainage No.	**31.000**	**31.500**	**32.000**	**32.500**	**33.000**	**33.500**	**34.000**	**34.500**	**35.000**	**35.500**	**36.000**
Pit No	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**
Modified Proctor Test											
Maximum Dry Density (G/Cc)	**1.670**	**1.830**	**1.800**	**1.750**	**2.045**	**2.010**	**1.970**	**1.850**	**1.900**	**1.800**	**1.880**
Optimum Moisture Content (%)	**18.40**	**16.40**	**18.30**	**20.40**	**10.00**	**11.40**	**11.20**	**16.10**	**13.60**	**16.60**	**13.60**
Atterberg`S Limit											
Liquid Limit (%)	**41.000**	**31.000**	**3.400**	**39.200**	**Non Plastic**	**Non Plastic**	**Non Plastic**	**Non Plastic**	**Non Plastic**	**Non Plastic**	**34.000**
Plastic Limit (%)	**22.304**	**19.618**	**21.351**	**21.637**							**21.618**
Plasticity Index (%)	**18.696**	**11.382**	**13.049**	**17.563**							**12.382**
Sieve Analysis											
Gravel (%)	**19.00**	**16.80**	**22.80**	**6.40**	**54.60**	**52.60**	**11.60**	**8.60**	**10.80**	**13.60**	**14.80**
Sand (%)	**26.40**	**39.20**	**38.20**	**27.40**	**33.00**	**34.20**	**64.20**	**68.20**	**60.40**	**61.20**	**40.20**
Silt & Clay (%)	**54.60**	**44.00**	**39.00**	**66.20**	**12.40**	**13.20**	**24.20**	**23.20**	**28.80**	**25.20**	**45.00**
California Bearing Ratio (Soaked)											
C.B.R. At 2.5 Mm	**6.215**	**8.287**	**7.342**	**6.842**	**9.152**	**8.248**	**6.441**	**8.574**	**8.926**	**7.219**	**8.587**
C.B.R. At 5 Mm	**6.177**	**8.196**	**7.281**	**6.654**	**8.939**	**8.011**	**6.177**	**8.382**	**8.761**	**7.081**	**8.286**
Free Swell Index											
Free Swell Index	**40%**	**20%**	**30%**	**50%**	**20%**	**20%**	**30%**	**20%**	**20 %**	**30%**	**20 %**

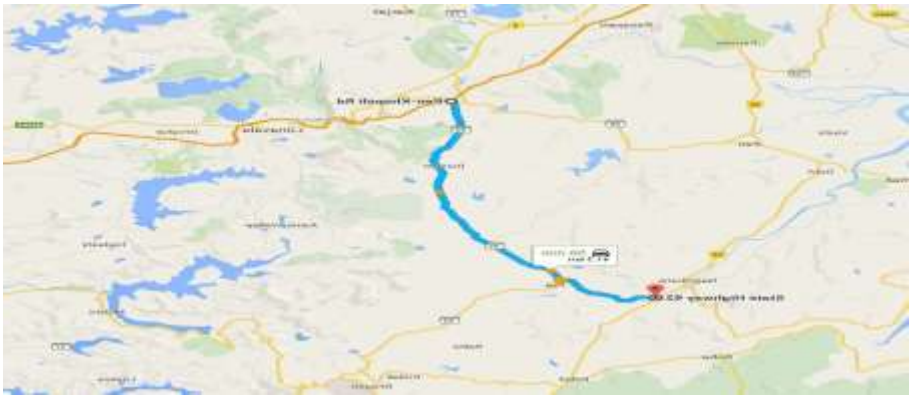

Fig 2. Map showing wakan – khopoli road location (source: Google map)

The objective of the road and pavement condition survey is to identify defects and sections with similar characteristics. All defects systematically referenced, recorded and quantified for the purpose of determining the mode of rehabilitation. The pavement condition surveys carried out using visual observations, supplemented by actual measurements and in accordance with the widely accepted methodology. The measurement of rut depth measured using standard straight edges. The shoulder and embankment conditions evaluated by visual means

and the existence of distress modes (cuts, erosion marks, failure, drops) and the extent (none, moderate, frequent and very frequent) of such distress manifestations are recorded.

Table no III : Soil Testing

PROJECT /SITE	**: Road NH from Wakan-Pali-Khopoli Road (SH-93 from Km. 36/500 to 41/000)**									
CHAINAGE NO.	**36.500**	**37.000**	**37.500**	**38.000**	**38.500**	**39.000**	**39.500**	**40.000**	**40.500**	**41.000**
PIT NO	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**
MODIFIED PROCTOR TEST										
Maximum dry density (g/cc)	**1.860**	**1.880**	**1.780**	**1.760**	**1.852**	**1.840**	**1.845**	**1.870**	**1.850**	**1.810**
Optimum moisture content (%)	**13.40**	**13.60**	**18.40**	**18.60**	**16.40**	**16.30**	**16.50**	**17.40**	**16.60**	**16.40**
ATTERBERG`S LIMIT										
Liquid limit (%)	**35.7**	**33.800**	**42.600**	**45.200**	**36.300**	**39.400**	**37.700**	**36.000**	**40.800**	**38.200**
Plastic limit (%)	**22.242**	**20.418**	**26.851**	**25.976**	**22.942**	**23.702**	**22.715**	**20.417**	**21.326**	**22.873**
Plasticity index (%)	**13.458**	**13.382**	**15.749**	**19.224**	**13.358**	**15.698**	**14.985**	**15.583**	**19.474**	**15.327**
SIEVE ANALYSIS										
Gravel (%)	**23.20**	**16.80**	**24.80**	**17.00**	**12.60**	**14.60**	**15.70**	**23.80**	**18.80**	**11.00**
Sand (%)	**41.40**	**41.20**	**40.00**	**39.80**	**45.00**	**38.20**	**37.30**	**40.80**	**39.20**	**32.40**
Silt & clay (%)	**35.40**	**42.00**	**35.20**	**43.20**	**42.40**	**47.20**	**47.00**	**35.40**	**42.00**	**56.60**
CALIFORNIA BEARING RATIO (SOAKED)										
C.B.R. At 2.5 MM	**8.752**	**8.427**	**7.048**	**7.232**	**7.856**	**7.684**	**7.842**	**8.022**	**7.972**	**7.684**
C.B.R. At 5 MM	**8.648**	**8.356**	**6.852**	**7.156**	**7.762**	**7.458**	**7.759**	**7.985**	**6.884**	**7.608**
FREE SWELL INDEX	**20%**	**20%**	**30%**	**30%**	**30%**	**30%**	**30%**	**20%**	**30%**	**40%**

4.2. Traffic Analysis:

The data (primary and secondary) collected was analyzed to obtain information on ADT, Seasonal variation, AADT, traffic composition, Peak Hour traffic, travel pattern, and commodity movement.

The composition of cars/vans and jeeps was found to be highest (45%) in section from Imagica to Khopoli junction. The composition of two wheelers was found to be36% across the sections. Trucks and heavy vehicles found to be6%.

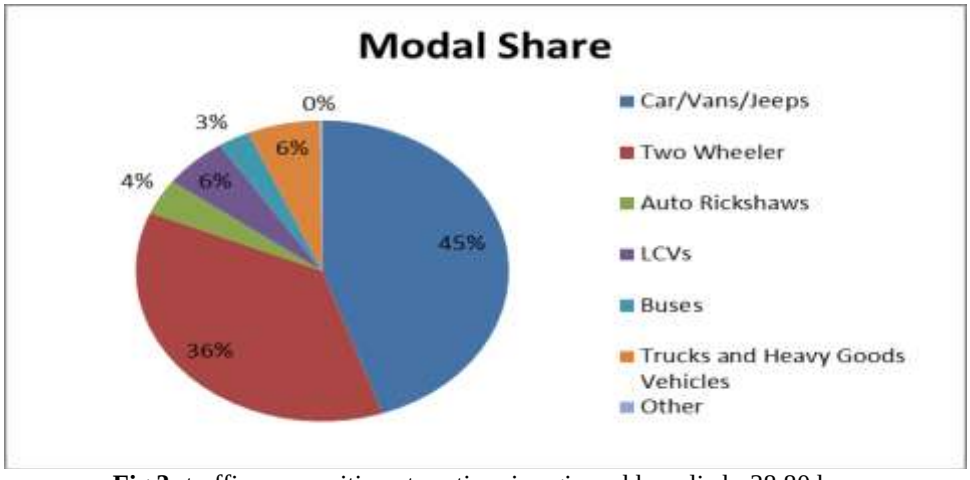

Fig 3: traffic composition at section: imagica – khopoli ch: 38.80 km

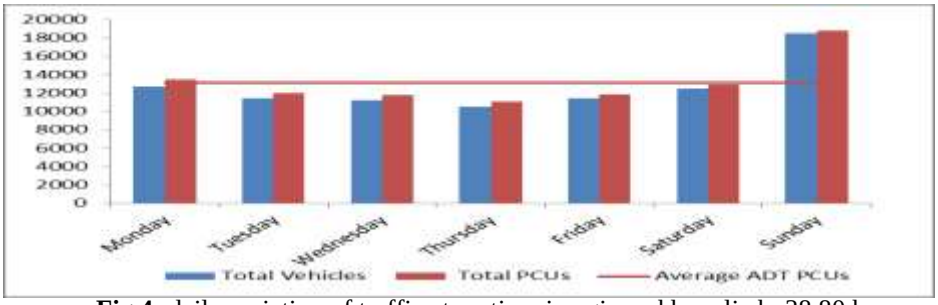

Fig 4: daily variation of traffic at section: imagica – khopoli ch: 38.80 km

V. CONCLUSIONS

For study purpose we have consider case study of 10 km road. After conducting traffic survey, different types of lab tests and data collection (current and historical) conclusions drawn are.

- The traffic intensity has increased hence it is necessary for smooth movement of traffic to widen the road and to strengthen the shoulder portion. From the inventory it is found that bridges and pipe culverts are in bad condition, hence renovation & reconstruction are necessary.
- From current surface condition, pot holes, transverse cracks, alligator cracks are observed ,hence pot hole filling, sealing of cracks are required.
- Soil testing revels that from CH 33 to CH 35 non plastic soil and Aterbergs limit is in range.
- From CBR value it is found that structurally existing road is in sound condition.
- Timely maintenance will saves cost of reconstruction, travel time of commuters, will allow smooth traffic movement, and reduce chances of accidents.

5.1. Suggestions:

- Rigid pavement has is proposed in areas as well as in built-up sections.
- Service roads are required near crowded villages.
- Bus shelters and bus bays have been proposed on the project road for comfort of passengers and better movement of traffic.

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