KSCSTE-NATIONAL TRANSPORTATION PLANNING AND RESEARCH CENTRE

KSCSTE-NATPAC

Mobility NEWS LETTER

Volume XIV, Issue 4 October - December 2016

Editorial...

"Pavements shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner." Effective pavement design is one of the most important aspects of project design. The pavement is the portion of the highway which is most obvious to the motorist. The condition and adequacy of the highway is often judged by the smoothness or roughness of the pavement. Deficient pavement conditions can result in increased user costs and travel delays caused by frequent breaking, higher fuel consumption, vehicle maintenance repairs and probability of increased crashes. A properly designed pavement structure will take into account the applied loading.

An effective rehabilitation strategy must treat the underlying cause of pavement distress and prevent it from recurring. Pavement management systems can help highway authorities and engineers to achieve great savings, as well as to protect the public infrastructure and maintain safety.

Each layer of pavement has a multitude of functions to perform which has to be duly considered during the design process. Different types of pavements can be adopted depending upon the traffic requirements. Improper design of pavements leads to its early failure of pavements affecting the riding quality. This issue of Mobility Newsletter looks into the formulation of pavement design strategy for the road stretch from Ambalappuzha to Thiruvalla section in Alappuzha district.

1. FORMULATING PAVEMENT DESIGN STRATEGY FOR THE ROAD STRETCH FROM AMBALAPPUZHA TO THIRUVALLA IN ALAPPUZHA DISTRICT, KERALA.

Public Works Department, Government of Kerala, entrusted KSCSTE-National Transportation Planning and Research Centre, (NATPAC), the task of formulating pavement design strategy for the road stretch from Ambalappuzha to Podiyadi near Thiruvalla in Alappuzha district.

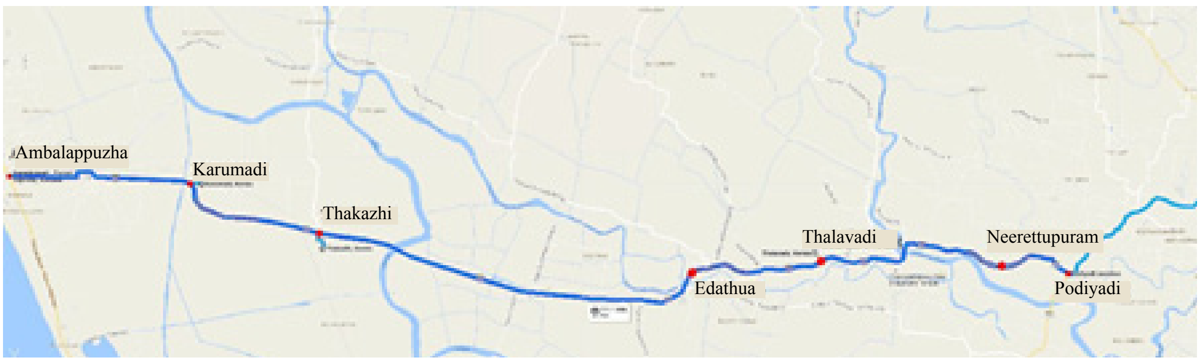

Figure 1 : Study Stretch

The scope of the study was confined to the design of pavement for the stretch starting from Ambalappuzha and ending at Podiyadi near Tiruvalla for a length of 23.5 kms. The objective of the study was to determine the pavement rehabilitation strategy for the stretch.

The major tasks involved in the project were to;

- Detailed reconnaissance and road inventory survey to appreciate the topographical features and typical physical features along the project site;
- Visual inspection of the condition of the pavement throughout the project stretch;
- Study of the existing traffic characteristics along the project stretch;
- Study of the performance of pavement related to the deflection of the flexible pavement measured by Benkelman beam;
- Study of the properties of the subgrade soil of the existing pavement along the project stretch;
- Recommend rehabilitation measures for the existing pavement and new pavement design for the deteriorated sections.

Methodology

Methodology adopted is shown in **Figure 2**.

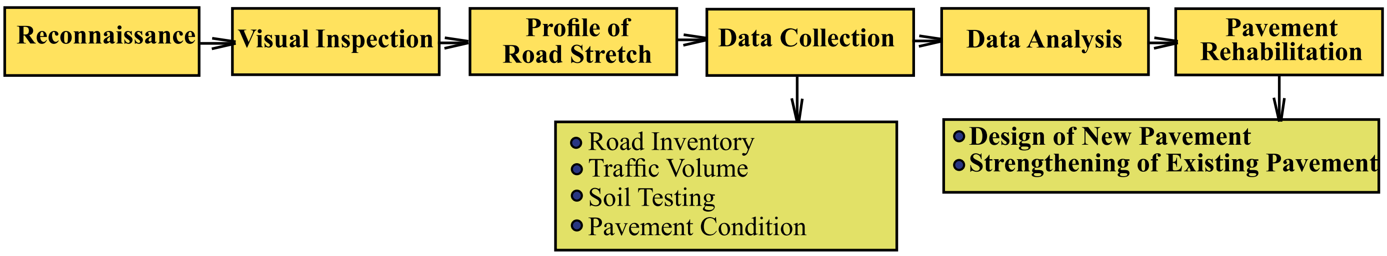

Figure 2 : Methodology adopted for the study

The subgrade soil samples were taken from 10 locations along the corridor of the project road. It was found that the subgrade soil was mostly sandy with different percentage of fines. In general, they can be classified as Silty Sand, Highly compressible silt and poorly graded silty sand with little fines. The Optimum Moisture Content (OMC) varies from 0.42% to 21.12% across the road corridor and the Maximum Dry Density (MDD) varies from 1.61 g/cc to 2.096 g/cc. The Plasticity Index (Ip) values ranged from 2.06% to 27.82%. The CBR values ranged from 8.8% to 34.2%.

Pavement Condition Survey was done for collecting the basic information of the road structure and based on this, the road was demarcated into homogeneous sections of more or less equal/ uniform performance or sections of similar characteristics to obtain homogeneous sections.

The pavement of the Ambalappuzha – Thiruvalla road was of flexible type having earthen shoulders, condition of which varied from being fair to highly damaged condition. The pavement was showing signs of distress due to lack of drainage, settlement of embankment and flooding of pavement during rainy season. Flooding of pavement was caused by low height of embankment and rise in the water table. **Table 1** shows the distress on various levels.

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Table 1: Summary of the Distress in Various Links

Sl. No.	Section	Length (km)	Distress	Pavement Condition
1	Ambalappuzha - Karumadi	4	Pot holes, patching	Good to fair
2	Karumadi - Thakazhi	3	Heavy distress	Very poor
3	Thakazhi - Edathua	8	Pot holes	Fair
4	Edathua - Neerettupuram	4.5	Heavy distress	Very poor
5	Neerettupuram - Podiyadi	4	Small patching	Good

Evaluation of structural strength for existing pavement using Benkelman Beam Deflection technique (BBD) as shown in **Figure 3,** was carried out in accordance with the procedure given in IRC: 81-1997. The deflection varied from 0.55 mm to 3.28 mm for different sections.

Figure 3 : Structural strength evaluation for existing pavement using Benkelman Beam Deflection

Design of new Pavement and Strengthening of Existing Pavement

- Pavement Rehabilitation Strategy

Based on careful review of the discussed strength parameters and their inter-relationships along with traffic considerations, division of the corridor in to various homogeneous sections was evolved. For the initial 2 km and the last 2.5km, the mean deflection value 0.81 mm and 0.75 mm respectively and the pavement surface condition was observed to be in good to fair condition. Moreover the soil characteristics in the section was also found to be good. Hence, it would be adequate to provide overlay for those sections. For the sections from chainage 2km to 20km, the pavement was heavily damaged and was full of distress. In addition to this, the deflection obtained was high (ranging from 1.30 to 3.27 mm). Under such circumstances, it would not desirable to overlay the existing surface which would likely result in premature failure of pavement. Hence it was recommended to reconstruct the pavement for the sections from km 2 to 20. **Table 2** gives a summary of the recommended rehabilitation strategy.

Table 2: Summary of the Rehabilitation Stratergy

Sl. No.	Chainage (km)	Recommended Construction Strategy
1	0.00-2.00	Overlay
2	2.00-20.00	New pavement
3	20.00-23.50	Overlay

- Design of Overlay as per IRC: 81-1997

The design of overlay for the existing pavement was carried out taking into account the traffic flow and strength of the existing pavement based on detailed pavement investigation including BBD testing. **Table 3** shows the recommended ocerlay design thickness.

Table 3: Recommended Overlay Design Thickness

Chainage (km)	Deflection (mm)	Overlay Design
0-2	0.81	40 mm BC over 50 mmDBM
20-22.5	0.75	

- Pavement Design for Stretches Warranting Reconstruction

The stretches identified for reconstruction were highly distressed with extensive cracking and ravelling and hence it would not be desirable to overlay such surface. Overlay on these stretches would most likely will result in reflection cracking in due course of time. Hence new pavement construction was recommended for these stretches as shown in **Table 4**.

Table 4: Pavement Design for Reconstruction

Chainage (km)	Length (km)	Design CBR (%)	Design Traffic (msa)	Proposed Pavement Layers (mm)				
				BC	DBM	WMM	GSB	Total
2-7	5	15	12.87	40	45	250	200	535
7-20	13	10		40	60	250	200	550

2. TRAINING PROGRAMMES CONDUCTED

In-house Training

i) Demonstration of Matlab Software to Scientists and Technical Officers by M/s Math Works Image Processing and Computer Vision Technologies on 27th October 2016.

3. PARTICIPATION IN WORKSHOPS, SEMINARS/CONFERENCES AND OTHER TRAINING PROGRAMMES

Name of Programme	Organised by	Date(s)	Venue	Participants
Seminars/Conferences				
KERALA STATE MEET - 2016, Promoting Space Technology Based Tools and Applications towards Governance and Development	ISRO and Kerala State Remote Sensing and Environment Centre (KSREC)	08.11.2016	Hotel Hycinth Thiruvananthapuram	M S Saran
Geo Vision Seminar 2016	ESRI India	09.12.2016	Hilton Garden Inn, Thiruvananthapuram	M S Saran
Trainings				
GIAN Course on "Non Destructive Testing of Pavements from Cradle to Grave"	IIT, Madras, Chennai	05.12.2016-10.12.2016	IIT, Madras	V S Sanjay Kumar A Jegan Bharath-Kumar
GIAN course on "Building Resilient and Sustainable Roadway Infrastructure	IIT, Madras, Chennai	12.12.2016-23.12.2016	IIT, Madras	P N Salini R Chandra Prathap U Salini

4. STUDENTS' TRAINING/PROJECT WORK AND THESIS

Detailsof guidance provided by the Scientific Divisions to students from various National Institutes and reputed Professional Colleges during this period is given below:

Name of the Institution	Course	Guide	No.of Students	Topic
Sarabhai Institute of Science and Technology, Thiruvananthapuram	B Tech (Civil)	Sabitha N M	3	Runoff estimation and identification of flood risk area using GIS
Gurudeva Institute of Science and Technology Kottayam	B Tech (Civil)	Sabitha N M	5	Threats in Inland Waterway Transportation (Alappuzha - Kottayam Canal)
Musaliar College of Engineering and Technology, Pathanamthitta	B Tech (Civil)	P N Salini	4	
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Ebin Sam	1	Driver behaviour at pedestrian crossings
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Ebin Sam	1	Development of GIS based traffic-road database

5. PUBLICATIONS

Papers Published in Referred Journals

1. **Vishnu Krishnan, V K Arora, Salini U**, "Evaluation of Jarofix-Soil Embankment using Numerical Modelling", International Journal of Earth Sciences and Engineering, Vol.09 (6), December 2016, P.P.2871-2877.

Conferences

1. **Shaheem S, T Ramakrishnan, B G Sreedevi**, "Sustainable Urban Transit System for Thiruvananthapuram City in Kerala". 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Thiruvananthapuram, 28-30 November 2016.

2. **P Kalaiarasan**, "Vehicular Emission Ranking of Major Road Corridors in Thiruvananthapuram Urban Centre". 12 Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Thiruvananthapuram, 28-30 November 2016.

3. **Sabitha N M, B G Sreedevi**, "Renovation of Inland Waterways for Tourism and Passenger Transport- A case study of Kadambrayar River in Kochi". Proceedings of 12 Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Thiruvananthapuram, 28-30 November 2016.

4. **Sabitha N M, Santosh G Thampi, Sathish Kumar D**, "Estimation of flood hazard map for Killi Basin using GIS based Morphometric parameters". Poster presented at National Symposium on Recent Advances in Remote Sensing and GIS with Special Emphasis on Mountain Ecosystems organised by Indian Institute of Remote Sensing at Dehradun, 7–9 December 2016.

5. **Sabitha N M, Santosh G Thampi, Sathish Kumar D**, "GIS based morphometric analysis for flash flood estimation in Killi Basin". Proceedings of the 21st International Conference on Hydraulics, Water Resources and Coastal Engineering (HYDRO 2016), organised by The Central Water and Power Research Station (CWPRS), Pune, 8-10 December 2016.

6. **Sabitha N M, B G Sreedevi**, "Management of Inland Waterways for Tourism and Passenger Transport in Kochi Region". Proceedings of 21st International Conference on Hydraulics, Water Resources and Coastal Engineering (HYDRO 2016) organised by The Central Water and Power Research Station (CWPRS), Pune, 8-10 December 2016.

7. **Wilson K C, P N Salini, V S Sanjay Kumar**, "Transportation Demand Management for an IT Park with Direct Access to National Highway". 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC, Thiruvananthapuram, 29-30 November 2016.

8. **Jobson Joseph, B Anish Kini**, "Impact of Implementing Congestion Charging using PTV Vissim". Urban Mobility India Conference 2016 at Gandhi Nagar, 8-11 November 2016.

9. **Vishnu Krishnan, Arora V K, Salini U**, "Utilization of Biaxial Geogrid in Embankments Constructed with Jarofix". 6th Asian Regional Conference on Geosynthetics at New Delhi, 8-1 November 2016.

10. **Anoop T Vijayan, Remjish R S, Salini U, B G Sreedevi**, "Use of Coir Fibre in Stone Matrix Asphalt for Pavement Construction". 6th Asian Regional Conference on Geosynthetics at New Delhi, 8-11 November 2016.

11. **Aswathy M, Gayathri V G, Salini U**, "Utility of Lime and Red Mud in Clay Soil Stabilization". Proceedings of Indian Geotechnical Conference (IGC 2016) at IIT Madras, 15–17 December 2016.

12. **Laya N N, Salini U**, "Lime Stabilization of Subgrade with Waste Sand as Partial Soil Replacement". Proceedings of Indian Geotechnical Conference (IGC 2016) at IIT Madras, 15–17 December 2016.

- ***Articles***

B G Sreedevi, T Ramakrishnan, Ebin Sam, "Managing Thiruvananthapuram M.G road" Traffic Infratech Magazine (August-September 2016; Volume-7, Issue-1).

6. INVITED TALKS

Salini P N, Scientist

'Highway Materials and Pavement Evaluation'. Talk delivered at Ilahia College of Engineering and Technology on request of Civil Engineering Association, 31st October 2016.

7. NOMINATIONS TO TECHNICAL COMMITTEES/ADVISORY BODIES

P Kalaiarasan, Scientist

Nominated as Nodal Officer for Climate Change Cell, Directorate of Environment and Climate Change, Govt. of Kerala.

Do You Know?

PAVEMENT

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution.

An ideal pavement should meet the following requirements:

Sufficient thickness to distribute the wheel load to the sub-grade soil

Structurally strong to withstand all types of stresses imposed upon it

Adequate coefficient of friction to prevent skidding of vehicles

Smooth surface to provide comfort to road users even at high speed

Produce least noise from moving vehicles

Dust proof surface so that traffic safety is not impaired by reducing visibility

Impervious surface, so that sub-grade soil is well protected

Long design life with low maintenance cost

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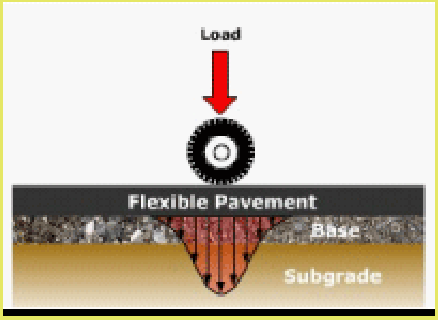
Types of Pavement

Flexible Pavement

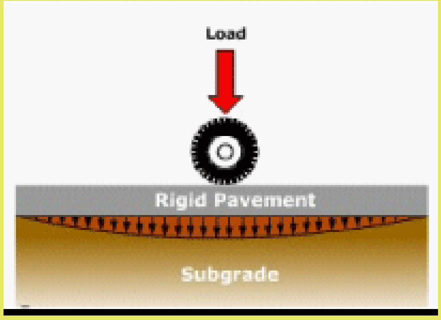
Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure

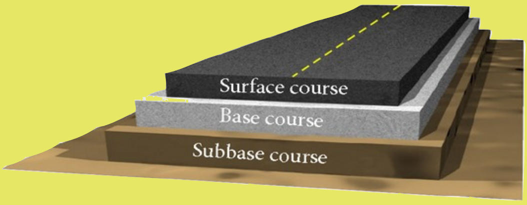
Rigid Pavement

Rigid pavements have sufficient flexural strength to transmit the wheel load stresses to a wider area below.

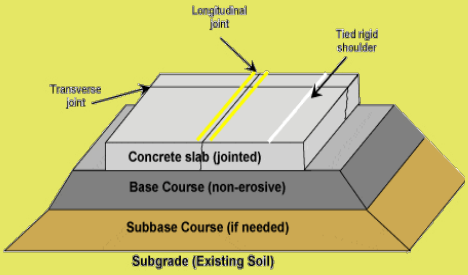


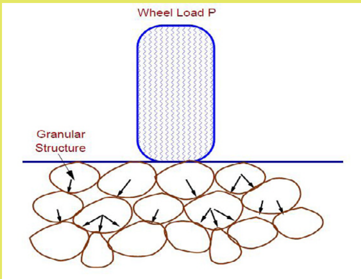
Transmission of load



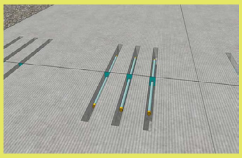


Cross section





Grain-to-grain load transfer



Dowelbar For inter connection

Rigid pavement

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