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.

<table>
<thead>
<tr>
<th>Reconnaissance</th>
<th>Visual Inspection</th>
<th>Profile of Road Stretch</th>
<th>Data Collection</th>
<th>Data Analysis</th>
<th>Pavement Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Inventory</td>
<td>Traffic Volume</td>
<td>Subgrade Testing</td>
<td>Pavement Condition</td>
<td></td>
<td>Design of New Pavement Strengthening of Existing Pavement</td>
</tr>
</tbody>
</table>

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.
Based on careful review of the discussed strength parameters and their inter-relationships along with traffic considerations, division of the corridor into various homogeneous sections was evolved. For the initial 2 km and the last 2.5 km, 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 were also found to be good. Hence, it would be adequate to provide overlay for those sections. For the sections from chainage 2 km to 20 km, 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 be 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 Strategy

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Chainage (km)</th>
<th>Recommended Construction Strategy</th>
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<tbody>
<tr>
<td>1</td>
<td>0.00-2.00</td>
<td>Overlay</td>
</tr>
<tr>
<td>2</td>
<td>2.00-20.00</td>
<td>New pavement</td>
</tr>
<tr>
<td>3</td>
<td>20.00-23.50</td>
<td>Overlay</td>
</tr>
</tbody>
</table>

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**

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- **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 overlay design thickness.

Table 3 gives a summary of the recommended overlay design thickness.
2. TRAINING PROGRAMMES CONDUCTED

In-house Training


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

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

<table>
<thead>
<tr>
<th>Chainage (km)</th>
<th>Length (km)</th>
<th>Design CBR (%)</th>
<th>Design Traffic (msa)</th>
<th>Proposed Pavement Layers (mm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-7</td>
<td>5</td>
<td>15</td>
<td>12.87</td>
<td>BC: 40, DBM: 45, WMM: 250, GSB: 200</td>
<td>535</td>
</tr>
<tr>
<td>7-20</td>
<td>13</td>
<td>10</td>
<td></td>
<td>BC: 40, DBM: 60, WMM: 250, GSB: 200</td>
<td>550</td>
</tr>
</tbody>
</table>

Table 3: Recommended Overlay Design Thickness

<table>
<thead>
<tr>
<th>Chainage (km)</th>
<th>Deflection (mm)</th>
<th>Overlay Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0.81</td>
<td>40 mm BC over 50 mmDBM</td>
</tr>
<tr>
<td>20-22.5</td>
<td>0.75</td>
<td></td>
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4. STUDENTS’ TRAINING/PROJECT WORK AND THESIS

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

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

5. PUBLICATIONS

- **Papers Published in Referred Journals**


- **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.


**Articles**

6. INVITED TALKS

Salini P N, Scientist


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?

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

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.
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.

Flexible Pavement

Dowelbar for interconnection

Rigid Pavement

Cross section

Transmission of load