Design of Rural Road with Stabilised Base

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Abstract

The design was taken up with an objective of quantifying the benefits of using bitumen emulsion stabilised base course in rural roads.

The important aspect of developing low volume roads in rural areas is to aim at providing basic access at minimum cost covering as many villages as possible, within the allocated funds. To keep the developmental costs to minimum along with appropriate levels of serviceability, choice of material is an important consideration.

It is an established fact that the choice of the type of pavements and its design is normally decided on the basis of initial construction cost, availability of the required material, cost of maintenance or rehabilitation during the service life of the road. Even though, variety of pavements types are available and are technically feasible, flexible pavements are the main choice for the rural roads due to the inherent ease with which they can be designed, constructed and maintained. The main issues required to be understood and to be addressed while designing the flexible pavements are the number of layers and the composition of each layer with different materials, so as to achieve the objectives of pavement design namely load bearing capacity, load dispersion, elastic deformation, riding quality and the durability.

For the design of flexible pavement, the main parameters identified are the type of soil sub-grade as reflected by its strength or load bearing capacity and the expected traffic on the road during its design period derived from annual average daily traffic (AADT), particularly the commercial vehicles, normally referred to as CVPD i.e. Commercial Vehicle Per Day.

Apart from above, there is urgent need of economical and innovative technology that reduces consumption of energy as well as material in manufacturing and placing of unbound granular material (WBM/WMM) without compromising on strength and durability. To keep the costs to minimum, the choice of material, ease of construction with the application of machinery, low consumption of material and least environment impact are therefore important considerations.

IRC:37-2012 guidelines, incorporates some of the new and alternate materials in the current design practices based on sound engineering judgment. In semi-mechanistic approach for design of pavement, one of the method is use of "bitumen emulsion" in Stabilisation of WMM in base course. This is expected to provide better pavement structure with minimal maintenance and rehabilitation requisites. Use of bitumen emulsion in base course will reduce
requirement of virgin aggregate. This method has still not found place in "Guidelines for the design of flexible pavements for low volume rural roads IRC:SP:72-2015".

Traffic composition on low volume rural roads corresponds mainly to T₃ traffic category (ESAL between 60,000 to 1,00,000) as defined in IRC:SP:72-2015 in the State of Uttar Pradesh.

The pavement is checked for rutting failure criterion at sub-grade level for conventional design vs stabilised WMM layer using software IITPAVE which was developed as part of the design code IRC:37-2012 for the following CBR value & thickness as below:

![Diagram showing conventional and new method pavements with granular base, S.WMM, and GSB layers.]

### Table 1
**Strain at Sub grade level**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sub grade CBR</th>
<th>Pavement thickness</th>
<th>Rutting Strain at Sub grade</th>
<th>Allowable strain corresponding to 20 mm rutting for ESAL 100000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WBM</td>
<td>S.WMM</td>
<td>WBM</td>
</tr>
<tr>
<td>1</td>
<td>5%</td>
<td>275</td>
<td>200</td>
<td>1.73E-03</td>
</tr>
<tr>
<td>2</td>
<td>3.5% to 5%</td>
<td>325</td>
<td>240</td>
<td>2.03E-03</td>
</tr>
</tbody>
</table>

The vertical rutting strain at sub-grade level is fairly within the allowable limit of strain corresponding to ESAL 100000 for Stabilised WMM even after reducing its thickness considerably.

The Core Technical Committee of UP PWD decided to Construct the Rural Road of T₃ category (ESAL between 60,000 to 1,00,000) on Experimental basis with the following details and design using IIT PAVE:
I  For CBR 5%
   - Granular Sub base  100 mm
   - WMM stabilize with 3.5% emulsion and 1% cement  100 mm
   - Premix Carpet  20 mm
   - Seal coat

II  For CBR 3.5% to 5%
   - Granular Sub base  100 mm
   - WMM stabilize with 3.5% emulsion and 1% cement  140 mm
   - Premix Carpet  20 mm
   - Seal coat

III  For CBR < 3.5% (including black cotton soil)
   - Stabilisation of soil in 30 cm depth in full width With 2% lime
   - Stabilisation of soil in 26 cm depth in shoulders, if soil is black cotton With 2% lime
   - Granular Sub base  100 mm
   - WMM stabilize with 3.5% emulsion and 1% cement  140 mm
   - Premix Carpet  20 mm
   - Seal coat

A typical analysis of construction cost for above mentioned composition of pavement in terms of material, machinery and labour indicate a saving of about 8 to 10% against design carried out using conventional method & cost incurred thereon.
Table 2
Saving in Cost

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sub grade CBR</th>
<th>Cost of Pavement per km Traffic category T₃ (ESAL 1,00,000) as per IRC: SP 72-2015</th>
<th>with Stabilised WMM</th>
<th>% reduction in Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5%</td>
<td>66.00 lacs</td>
<td>58.40 lacs</td>
<td>11.52%</td>
</tr>
<tr>
<td>2</td>
<td>3.5% to 5%</td>
<td>74.50 lacs</td>
<td>68.70 lacs</td>
<td>7.79%</td>
</tr>
<tr>
<td>3</td>
<td>&lt;3.5% including Black cotton soil</td>
<td>90.00 lacs</td>
<td>84.41 lacs</td>
<td>6.21%</td>
</tr>
</tbody>
</table>

Table 3
Saving in Quantities

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Sub grade CBR</th>
<th>Pavement thickness as per IRC: SP 72-2015</th>
<th>Pavement thickness as with Stabilised WMM</th>
<th>% reduction in Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5%</td>
<td>275</td>
<td>200</td>
<td>26.15%</td>
</tr>
<tr>
<td>2</td>
<td>3.5% to 5%</td>
<td>325</td>
<td>240</td>
<td>27.27%</td>
</tr>
</tbody>
</table>

The major benefit in constructing rural road with above composition, apart from reduction in cost is the conservation of natural resources and energy along with preservation of the environment, which would take the rural road construction industry on a faster pace, if such construction of rural roads are encouraged and popularized.

Apart from above, the life & performance of PC with seal coat over strong base will also increase as compared to conventional WBM.

During implementation of such Projects, the field engineers are to be involved right from Project Preparation stage. All technical and implementation processes should be documented for its future evaluation and for exposing more field engineers to these technologies.