USE OF THE DCP DESIGN METHOD IN THE DRC

Presenters Names: Estimé Mukandila
Michael Pinard
Co-authors Names: Anton Hartman
Nkululeko Leta
Outline of Presentation

- Location of project in the DRC
- State of roads in DRC
- Traditional pavement design and issues of CBR testing
- Main steps of DCP method for LVSR
- Comparison between Traditional and DCP design method
- Critical LVSR design parameters for DRC
Location of DRC

- DRC formerly Zaire
- Population: over 75 million
- Area: 2,344,858 Km²
- After 15 years of war
- Currently relatively peaceful
State of roads in DRC

> 30,000 km of unpaved road network

< 40% in good or fair condition

No reliable access to many communities

Need of proper LVSR design
Traditional Design Method

- Most of design methods use CBR as a key design factor
- Issues with CBR Test
  - No universal standard test method
    - Some test methods remove +19mm size from sample, doesn’t reflect the real strength of the material.
  - Not good representation of in-situ condition (moisture, strength, compaction)
  - Test not allow pore pressure release, thus not correct estimation of bearing capacity
- Development of DCP design for LVR
  - Provide composite measure of material properties influence by PI, grading, density and moisture.
CBR vs. DCP

DN depth of penetration +/- 135 mm

CBR depth of penetration +/- 25.4mm
Main steps of DCP method for LVSR

1. Determine Design period, Design Traffic, and Traffic classes
2. DCP and In-situ Moisture content survey
3. Determine DN value (use of software)
4. Adjust DN values for design moisture content
5. Determine in-situ Layer Strength Profile
6. Evaluate required Layer Strength Profile for uniform section
7. Determine upgrade requirement
8. Determine Uniform section (use of CUSUM method)
Determine uniform sections
Adjust DN values for design moisture content

- Adjustment of DN Values for Design moisture Content considering anticipated long-term in-service moisture content in pavement

<table>
<thead>
<tr>
<th>Condition</th>
<th>DN Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drier than at the time of DCP Survey</td>
<td>20\textsuperscript{th} percentile of DN</td>
</tr>
<tr>
<td>Same as at the time of DCP Survey</td>
<td>50\textsuperscript{th} percentile of DN</td>
</tr>
<tr>
<td>Wetter than at the time of DCP Survey</td>
<td>80\textsuperscript{th} percentile of DN</td>
</tr>
</tbody>
</table>
## Required layer-strength profile

<table>
<thead>
<tr>
<th>Traffic Class</th>
<th>LE 0.01</th>
<th>LE 0.03</th>
<th>LE 0.1</th>
<th>LE 0.3</th>
<th>LE 0.7</th>
<th>LE 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>E80 x 10^6</td>
<td>0.003 - 0.010</td>
<td>0.010 - 0.030</td>
<td>0.030 - 0.100</td>
<td>0.100 - 0.300</td>
<td>0.300 - 0.700</td>
<td>0.700 - 1.0</td>
</tr>
<tr>
<td>Max. DN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 150mm Base ≥ 98% Mod. AASHTO</td>
<td>8</td>
<td>5.9</td>
<td>4</td>
<td>3.2</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>150-300 mm Subbase ≥ 95% Mod AASHTO</td>
<td>19</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>4.6</td>
<td>4</td>
</tr>
<tr>
<td>300-450 mm Subgrade ≥ 95% Mod AASHTO</td>
<td>33</td>
<td>25</td>
<td>19</td>
<td>12</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>450-600 mm in situ material</td>
<td>40</td>
<td>33</td>
<td>25</td>
<td>19</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>600-800 mm in situ material</td>
<td>50</td>
<td>40</td>
<td>39</td>
<td>25</td>
<td>24</td>
<td>23</td>
</tr>
</tbody>
</table>
Evaluate in situ layer-strength profile for uniform sections
Performing laboratory DN value

- DN/moisture/density relationship required for suitable pavement material
- DCP used to penetrate the CBR mould
- Take in account pore pressure release during testing

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>DN Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 days soaked sample, sealed for 4 days in plastic bag</td>
<td>Soaked DN</td>
</tr>
<tr>
<td>Sample at OMC, sealed for 4 to 7 days in plastic bag</td>
<td>OMC DN</td>
</tr>
<tr>
<td>Oven sample (0.75OMC), sealed for 4 days in plastic bag</td>
<td>0.75 OMC DN</td>
</tr>
</tbody>
</table>
Performing laboratory DN value
Comparison between Traditional Method and DCP design method

- Traffic class: 0.1 - 0.30 Millions ESAs
- Climate: Wet

### TRH4

- Bituminous Surfacing
  - 125 Crushed or natural gravel, CBR >80% soaked @ 98% MDD, PI<6
  - 125 natural gravel, CBR >30% soaked @ 95% MDD, PI<12
  - 150 compacted gravel / soil, CBR >15% soaked @ 93% MDD, PI<6

### DCP

- Bituminous Surfacing
  - 150 Natural gravel, CBR >50% soaked @ 98% MDD, PI<16

In-situ soil

<table>
<thead>
<tr>
<th>DN value before</th>
<th>DN value after</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3</td>
<td>3.2</td>
</tr>
<tr>
<td>7.8</td>
<td>5.3</td>
</tr>
<tr>
<td>12.5</td>
<td>7.8</td>
</tr>
<tr>
<td>16.1</td>
<td>12.5</td>
</tr>
<tr>
<td>21.2</td>
<td>16.1</td>
</tr>
</tbody>
</table>

In-situ soil (original surface)
Cost comparison: LVR versus Standard Construction

- Typical cost comparison from Malawi

<table>
<thead>
<tr>
<th>Road Design Standard</th>
<th>Construction Cost (US$)</th>
<th>Cost Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVR</td>
<td>150,000</td>
<td>-</td>
</tr>
<tr>
<td>Class I</td>
<td>300,000</td>
<td>100</td>
</tr>
<tr>
<td>Class II</td>
<td>500,000</td>
<td>233</td>
</tr>
</tbody>
</table>
Critical low volume road design parameters for DRC

- Design traffic
- Type of in-situ material (tropical soil: Laterite)
- Climate (rainfall:>1500mm/year)
  - Effect of Moisture Content in the design
  - Storm-water drainage
Conclusion

- LVSR in the DRC Initiative taken by AFCAP and Crown Agents to be encouraged
- Using DCP Method: simple, cost effective and efficient
- Critical LVSR design parameters specific for DRC to be taken in account
- Social benefits: knowledge transfer, job creation, better & safer roads
Thank you

How can the implementation of LVSR in Africa benefit to the all world?