Long life pavement design

Donna James
HA Pavement Design & Materials Team Leader
Long-life Pavements

Research was undertaken into the performance of flexible (asphalt) pavements in the 1990s to determine how much the design thicknesses needed to be increased by in order to carry the ever increasing traffic design loads.
Long-life Pavements: How thick?

- **Future requirement**
- **Current traffic limit**
- **Experimental pavements**
- **Extrapolation?**

**Thickness of bound layer (mm)**
- 0
- 10
- 100
- 200
- 300
- 400
- 500
- 600

**Cumulative traffic (msa)**
- 0.01
- 0.1
- 1
- 10
- 100
- 1000
Research showed that thick (>250mm), well built flexible pavements did NOT deteriorate structurally as previously expected.

For such pavements,
- rutting was confined to the upper surface layers
- cracking initiated at the surface (with no evidence of “bottom-up” fatigue cracking)

(TRL Report 250)
Long-life Pavements

• 80% of Fully Flexible Motorways meet the deflection and thickness criteria

• 20% of Fully Flexible APTRs meet the deflection and thickness criteria
Long-life Pavements

![Graph showing standard deflection versus total thickness of bituminous material for long-life pavements and determinate life pavements. The graph indicates that as the total thickness increases, the standard deflection decreases, and there is a designated area for long-life pavements.]
Long life pavement design (TRL 250)

Figure 2.2: Design Thickness for Flexible Pavements: Recipe-based Specifications of Base
Material properties

- LLP in UK predominantly fully flexible
- Permitted asphalt base materials
  - EME2
  - DBM50/HDM
  - HRA/DBM125 (very rarely used)
- HBMs can be used in foundation design
- Pavement design based on stiffness
## Foundation Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Design Stiffness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>50MPa</td>
</tr>
<tr>
<td>Class 2</td>
<td>100MPa</td>
</tr>
<tr>
<td>Class 3</td>
<td>200MPa</td>
</tr>
<tr>
<td>Class 4</td>
<td>400MPa</td>
</tr>
</tbody>
</table>
# Foundation requirements

<table>
<thead>
<tr>
<th>Foundation Class</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Stiffness Modulus</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Target Unbound 40</td>
<td>Unbound 80</td>
<td>Fast Curing 300</td>
<td>Fast Curing 600</td>
<td></td>
</tr>
<tr>
<td>Target Bound 50</td>
<td>Bound 100</td>
<td>Slow Curing 150</td>
<td>Slow Curing 300</td>
<td></td>
</tr>
<tr>
<td>Minimum 25</td>
<td>50</td>
<td>Fast Curing 150</td>
<td>Fast Curing 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slow Curing 75</td>
<td>Slow Curing 150</td>
<td></td>
</tr>
</tbody>
</table>
UK Design method?

- Empirical: based solely on engineering experience or systematic collection of condition data over time
- Mechanistic: based on fundamental understanding of behaviour of materials, using models of physical processes and materials properties obtained from laboratory tests
Design Process

• Option 1: Use nomographs in HD26
• Option 2: Prepare analytical design – requires a Departure From Standards
Bitumen Stress Analysis in Roads

Presentation

Number of Systems (1-10): 1

System Description: TWY, HMB35, Type 1, 6F1, 3.5% CBR

No of Position Entries (1-10): 4

<table>
<thead>
<tr>
<th>Position Number</th>
<th>X Coordinate (m)</th>
<th>Y Coordinate (m)</th>
<th>Z (depth) Coordinate (m)</th>
<th>Layer No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.2800</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.2800</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.7600</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.7600</td>
<td>5</td>
</tr>
</tbody>
</table>
Design stiffness and process

- Design stiffness is at a reference condition of 5Hz and 20\degree C.
- It represents an ‘in-service’ effective layer stiffness, taking account of loading time, confinement and curing.
- Binder course assumed to have same properties as base.
- Surface course assumed modulus 2.5GPa and incorporated into design charts.
EME2 – The Future
Focus of research

• Practical experiment to demonstrate fatigue endurance limit
• Continue to focus on improving construction, specification and auditing