South African Experience on In situ Recycling with Bitumen Emulsion and Foamed Bitumen

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- Issues related to design
- Issues related to construction
- Political and social issues
- Conclusions
Introduction

- South African road network
- Environmental legislature
- Arrival of high speed recyclers
- Foamed bitumen = emulsion?
Issues related to design

- Lack of lab. mixers simulating field conditions

![Graph showing UCS (kPa) vs. Foamed Bitumen Content (%) for Pugmill and Hobart.](graph.png)
Issues related to design

- Optimum bitumen and active filler ratio
- Appropriate performance tests

<table>
<thead>
<tr>
<th>Material Code</th>
<th>ITS (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100-300</td>
</tr>
<tr>
<td>UCS (kPa)</td>
<td></td>
</tr>
<tr>
<td>700 - 1400</td>
<td>FB4</td>
</tr>
<tr>
<td>1400-2000</td>
<td>FB2</td>
</tr>
</tbody>
</table>
Issues related to design

- Pre-design pavement investigation
- Sampling of material
Issues related to design

◆ Comparison between emulsion and foamed bitumen treated layers

Proffered conditions for use of foamed bitumen:
- Early opening to traffic
- High initial moisture content

Proffered conditions for use of emulsion:
- Inadequate foaming properties
- Material temperature < 15°C
- Inadequate fines in the material (< 5%)
Issues related to design

- Mechanistic-empirical design method
  Distress mechanisms:
  - Effective fatigue
  - Permanent deformation
  Development of transfer functions

![Graph showing the relationship between Support (MPa) and Thickness (mm)].
Deep in situ recycling, design charts

Example:
70 MPa Support
ES0.3 (100 000 to 300 000 E80s)
190 mm, rounded 200 mm
Add construction tolerance
Issues related to construction

- Differences between conventional and high speed recycling
  - Cross or forward blend of material
  - Application of cement
  - Limited time for corrections
Issues related to construction: compaction

<table>
<thead>
<tr>
<th>Layer Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>250</td>
</tr>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Static mass of Primary Roller</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 t</td>
</tr>
<tr>
<td>15 t</td>
</tr>
<tr>
<td>20 t</td>
</tr>
<tr>
<td>25 t</td>
</tr>
</tbody>
</table>

- **FINE**
- **COARSE**

Material Grading

- **Smooth Drum**
- **Padfoot**
- **PTR**
Issues related to construction

- Construction in temp. < 15°C
  - Influence of aggregate temp. on particle coating
  - Foam suitability

<table>
<thead>
<tr>
<th>Foam Index (sec)</th>
<th>Aggregate 15°C</th>
<th>Aggregate 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;75</td>
<td>Unsuitable</td>
<td>Unsuitable</td>
</tr>
<tr>
<td>75 – 100</td>
<td>Very poor</td>
<td>Poor</td>
</tr>
<tr>
<td>100 – 125</td>
<td>Poor</td>
<td>Moderate</td>
</tr>
<tr>
<td>125 – 175</td>
<td>Moderate</td>
<td>Good</td>
</tr>
<tr>
<td>75 – 200</td>
<td>Good</td>
<td>Very good</td>
</tr>
<tr>
<td>&gt;200</td>
<td>Very good</td>
<td>Very good</td>
</tr>
</tbody>
</table>

- Graph showing maximum particle size vs. aggregate mixing temperature.
Political and social issues

- Labour intensive construction (LIC)
- Development of small, micro and medium entrepreneurs
Political and social issues

In-plant mixing
- New / upgrading projects
- Control of input materials
- Quality of mixing
- Stockpiling
Labour-intensive construction
Labour Intensive Construction

- Quality of road surface finish
- Compaction
- Quality control
- Construction duration
Political and social issues

- LIC construction cost
- Social benefits of LIC
Recycling with Foamed Bitumen and Emulsion

Conclusions

- In place deep recycling and in plant recycling were successfully used in South Africa
- This technology can also be used for labour intensive construction
- Effective when carefully controlled
SA Experience on Recycling with Foamed Bitumen and Emulsion

- Interim Technical Guidelines: The Design and Use of Foamed Bitumen Treated Materials
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