Foamed Bitumen Stabilised Pavements

David Alabaster, Transit New Zealand
Alvaro Gonzalez, University of Canterbury
OUTLINE

• Current Design Issues
• CAPTIF Testing
• Thoughts so far
• Discussion
Current Design Issues

- Lack of performance information on cement and lime modified materials.
- Lack of performance information on foam-stabilised mixes.
- Up to 70% of rutting can be determined to the base layers.
Foamed Bitumen Stabilisation

1. Current Requirements,
   - elastic modulus of the order of 800 MPa;
   - Poisson’s Ratio = 0.3;
   - anisotropic layer;
   - no sub-layering.
Elastic Modulus (MPa) vs. Theta (kPa)

- 4.0% Bitumen, 1.0% Cement
- 2.0% Bitumen, 1.0% Cement
- 0.0% Bitumen, 1.0% Cement
- CL M4
- Greywacke1
- Andesite1
- Greywacke2
- Andesite2
- Dacite
- Andesite + cement
CSIR FB Design

- Optimum FB with 1% cement design

<table>
<thead>
<tr>
<th>Subgrade (CBR %)</th>
<th>Phase I (MESA)</th>
<th>Phase II (MESA)</th>
<th>Total (MESA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>0.35</td>
<td>0.03</td>
<td>0.38</td>
</tr>
<tr>
<td>6%</td>
<td>0.43</td>
<td>0.04</td>
<td>0.47</td>
</tr>
<tr>
<td>8%</td>
<td>0.50</td>
<td>0.05</td>
<td>0.55</td>
</tr>
<tr>
<td>10%</td>
<td>0.56</td>
<td>0.06</td>
<td>0.62</td>
</tr>
<tr>
<td>12%</td>
<td>0.61</td>
<td>0.07</td>
<td>0.68</td>
</tr>
</tbody>
</table>
# FWD Results

## Table 6. Subgrade and SNP results

<table>
<thead>
<tr>
<th>Section</th>
<th>Subgrade CBR</th>
<th>SNP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>10%tile</td>
</tr>
<tr>
<td>A</td>
<td>22.6</td>
<td>18.8</td>
</tr>
<tr>
<td>B</td>
<td>19.5</td>
<td>16.4</td>
</tr>
<tr>
<td>C</td>
<td>21.4</td>
<td>16.7</td>
</tr>
<tr>
<td>D</td>
<td>19.6</td>
<td>18.4</td>
</tr>
<tr>
<td>E</td>
<td>17.1</td>
<td>14.2</td>
</tr>
<tr>
<td>F</td>
<td>20.4</td>
<td>18.3</td>
</tr>
</tbody>
</table>

## Table 7. Modulus and Life Predictions

<table>
<thead>
<tr>
<th>Section</th>
<th>Base Modulus (MPa)</th>
<th>Life (MESA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>10%tile</td>
</tr>
<tr>
<td>A</td>
<td>286</td>
<td>264</td>
</tr>
<tr>
<td>B</td>
<td>391</td>
<td>349</td>
</tr>
<tr>
<td>C</td>
<td>704</td>
<td>487</td>
</tr>
<tr>
<td>D</td>
<td>346</td>
<td>295</td>
</tr>
<tr>
<td>E</td>
<td>214</td>
<td>152</td>
</tr>
<tr>
<td>F</td>
<td>356</td>
<td>292</td>
</tr>
</tbody>
</table>
Simple FE – Lab RLT

Plastic basecourse deformation (mm) vs. Number of load cycles (*1000)

- 2% FB, 0% C
- 0% FB, 0% C
- 0% FB, 1% C
- 2% FB, 1% C
7 Day Field RLT

Permanent Deformation Tests for CAPTIF Hunua Mixes (First Round)

CP 01 1.50%B 1.0%C (First)
CP 05 4.0%B 1.0%C (First)
CP 08 0.0%B 1.0%C (First)
CP 10 2.75%B 0.0%C (First)
CP 03 2.75%B 1.0%C (First)
CP X 0.0%B 0.0%C
CP11 0.0%B 0.0%C
Permanent Deformation Tests for CAPTIF Hunua Mixes (Second Round)

- CP 02 1.50%B 1.0%C (Second)
- CP 06 4.0%B 1.0%C (Second)
- CP 07 0.0%B 1.0%C (Second)
- CP 09 2.75%B 0.0%C (Second)
- CP 04 2.75%B 1.0%C (Second)
- CP X 0.0%B 0.0%C
- CP 11 0.0% B 0.0% C

28 Day Field RLT

Total Number of Cycles vs Permanent Deformation
Figure 4 Emu results at 50,000 load cycles
Thoughts so far

No strong conclusions yet but:

- CSIR uses bound model and yet coring/deflection/strain and VSD suggests it's not.
- New Zealand approach should have been validated with FWD but was not.
- Simple FE model needs work.
- RLT testing holds the most hope but accurate moisture prediction vital and stress may not be correct for FB materials (Alavro’s PhD)
- To determine whole of life costs it is vitally important to understand their performance
Stabilising- sustainability

Will stabilised pavements become more in demand?
Discussion

- TNZ looking to reduce waste and improve resource and energy efficiency.
  - Environmental Plan – Resource Efficiency
  - Waste and Energy Management Policy
- Looking to reduce rolling resistance to reduce energy use through a variety of means.
- Managing waste by reducing, reusing, recycling and substituting resources.
- Developing Waste and Energy auditing
Discussion

Does Stabilisation reduce Waste and improve Resource and Energy Efficiency?

- Stabilisation binders can require large amounts of energy to create/transport them.
- Stabilisation can lower rolling resistance
- Stabilisation can reduce waste and aggregate resource use.
- So the answer is maybe?
The End

If you want automatic notification of new specifications – email specs@transit.govt.nz

Contact Details:
David Alabaster
CAPTIF Manager/ Roading Engineer
David.Alabaster@transit.govt.nz