**EME demonstration project Q – March 2014**

**Getting the mix design to work**

Trevor Distin  
Boral Asphalt

**EME mix design**

- Performance based mix design method
  - Must meet performance based lab test criteria
  - Specification does not have a fix grading curve or target binder content
  - Densely graded with high binder content to achieve workability with target air voids
- Bitumen properties will provide mix with
  - Modulus which will depend on stiffness of bitumen
  - Rutting properties
- Binder content will provide mix with
  - Fatigue
  - Water proofing

**EME2 mix design process**

- Level 1: Workability & Moisture resistance
  - Moisture resistance
    - Gyro angle 0° (80°C @ 25Hz)
    - 150 mm mould
    - 10 cycles per min
    - Loading 240kPa
  - Workability
    - Gyro angle 2 - 3° (81% air voids)
    - 100 mm mould
    - 60 cycles per min

- Level 2: Rut resistance
  - Rut resistance
    - >130

- Level 3: Modulus
  - Modulus
    - >14000 MPa
    - (15°C @ 10Hz)

- Level 4: Fatigue resistance
  - Fatigue resistance
    - >750 ps (10°C @ 25Hz)

**Mix design test method comparison**

<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workability</td>
<td>Gyro angle 0° (80°C) 150 mm mould 10 cycles per min loading 600 kPa</td>
</tr>
<tr>
<td>Moisture</td>
<td>Duriez 10% air voids 7 days soak</td>
</tr>
<tr>
<td>Rut resistance</td>
<td>Large wheel 60,000 passes @ 60°C</td>
</tr>
<tr>
<td>Modulus</td>
<td>15°C @ 10Hz Direct tensile 25°C @ 10Hz Indirect tensile</td>
</tr>
<tr>
<td>Fatigue</td>
<td>10°C @ 25Hz 2 point trapezoidal 20°C @ 10Hz 4 point beam</td>
</tr>
</tbody>
</table>

**Development of EME mix**

- Don’t deviate from proven EME principles
  - Learn from UK (UK) experience
  - Focus on achieving performance properties under which mix will be required to perform

- Stage 1: Establish equivalent metrics to characterise performance properties
  - Conduct performance tests on imported EME2 from France
  - Using Australia test methods and temperature/loading conditions

- Stage 2: Develop locally available EME binder
  - Conduct performance tests on local aggregate & bitumen using EME2 mix design (grading, binder content, film thickness and VMA)

- Stage 3: Develop mix design which meets French EME2 spec
  - Using local EME binder and aggregates

- Stage 4: Manufacture and pave EME2 using local EME bitumen and aggregates in accordance with French EME2 mix design
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Stage 3  Develop mix design

- Source suitable binder and aggregates
  - Aggregate from Whinstanes and West Burleigh plants
  - SAMI EME ‘15/25’ bitumen
- Shipped materials to Colas central lab in France in March 2013
- Whinstanes mix design completed October 2013 & West Burleigh in February 2014

EME2 mix design process

<table>
<thead>
<tr>
<th>Level</th>
<th>Test</th>
<th>Specimen</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density test</td>
<td>Compaction</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rutting test</td>
<td>Water sensitivity</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moisture test</td>
<td>Racking</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fatigue test</td>
<td>Stiffness</td>
<td></td>
</tr>
</tbody>
</table>

Aggregates requirements

- High angularity & surface texture to create VMA
  - FI max 25
- Hardness
  - Impact value min 150 kN
  - LA coefficient max 25

Fines requirements

- PSD
  - > 75% < 0.075mm
- Rigden voids
  - 28 – 38%
- Methylene blue
  - max 10
- Delta R&B
  - 8 – 16 °C

Workability

Air voids after 100 gyros

- Servopac = 6.0%
- Gyropac = 7.0%
- 3.7% presat

Moisture sensitivity

Durietz

Wheel tracking

@ 60°C after 60k

Large wheel

- 1.5%

Small wheel = 1.6 mm

Large wheel = 0.75 mm
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### Modulus

- **Direct tensile**
  - @ 10Hz @ 15°C
  - 13077 MPa

- **Flexural**
  - @ 20°C ~ 8500 MPa

- **Resilient**
  - @ 25°C ~ 12 GPa

### Fatigue

- **Sinusoidal 2 point**
  - @ 25Hz @ 10°C

- **4PF = 504k cycles**
  - (haversine, 10Hz, 20°C, 400µm)

### Summary

<table>
<thead>
<tr>
<th>Property</th>
<th>Mix Design</th>
<th>Mix Properties</th>
<th>Whinstanes Mix Design</th>
<th>PSD &amp; BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen type</td>
<td>DG20</td>
<td>EME2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C600 ~ 20/30 pen</td>
<td>~ C600</td>
<td>15/25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Binder content</td>
<td>4.5%</td>
<td>5.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 0.075mm</td>
<td>6%</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMAS</td>
<td>20mm</td>
<td>14mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air voids</td>
<td>4.5 ~ 5.5%</td>
<td>2 ~ 5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Whinstanes Mix Design

- **SAMI 15/25 EME binder content = 5.6%**

### Plant Mix Results

<table>
<thead>
<tr>
<th>Test</th>
<th>DG20</th>
<th>EME2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue @ 20°C</td>
<td>40k</td>
<td>270k</td>
</tr>
<tr>
<td>Modulus @ 25°C</td>
<td>6.0 MPa</td>
<td>10.8 MPa</td>
</tr>
<tr>
<td>Rutting @ 60k</td>
<td>2.9 mm</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>TSR</td>
<td>99%</td>
<td>101%</td>
</tr>
<tr>
<td>TSR</td>
<td>758kPa</td>
<td>1280kPa</td>
</tr>
</tbody>
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Mix design issues

- Rigden voids limits
  - need to add fines
  - can we use hydrated lime?
- What AV do we target for testing (3 - 6%)
- Modulus test – indirect, direct or flexural
- Fatigue test – sinusoidal or haversine
- Must have linkage with pavement design