EME demonstration project Q – March 2014

What we need to know & learn

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Background

- Full depth asphalt thicknesses in excess of 400 mm in QLD
- There is a need to reduce the thickness of heavy duty asphalt pavements
- This can be achieved through higher performances; i.e. higher stiffness or better fatigue resistance (or both), while not compromising rutting resistance, moisture sensitivity and overall pavement performance
- Enrobés à Modulus Élevé (EME) – High modulus asphalt can be a cost effective answer
- EME class 2 (EME2) is not ‘only’ a material – it is a concept
- EME2 – fully performance based mix design, which is directly connected to a general mechanistic procedure (GMP) for pavement design in France
- EME2 will be referenced as EME in this presentation

Pavement model - example

Weighted Mean Annual Pavement Temperature - WMAPT

<table>
<thead>
<tr>
<th>Depth (mm)</th>
<th>Mix Design</th>
<th>Modulus (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>DG14</td>
<td>E₁ = 800 MPa</td>
</tr>
<tr>
<td>50</td>
<td>DG14</td>
<td>E₂ = 1650 MPa</td>
</tr>
<tr>
<td>365</td>
<td>DG20</td>
<td>E₃ = 2900 MPa</td>
</tr>
</tbody>
</table>

Fatigue performance

Asphalt materials behave differently

Real pavement temperatures

Cullen Ave West, Eagle Farm, QLD

EME projects in Australia

Implementation phase

- Exploratory study - preliminary laboratory test results. L Petho, E Denneman, EME Technology Transfer to Australia: An Exploratory Study, AP-T249-13
- Selection of equivalent Australian test methods and tentative specification limits.
- Structural pavement design, including trial setup and field validation.
- Cooperation with major asphalt and bitumen suppliers and AAPA.

<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austroads TT1908</td>
<td>(in progress).</td>
</tr>
<tr>
<td>TMR P9</td>
<td>(in progress).</td>
</tr>
</tbody>
</table>
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Objectives of the works
Austroads & TMR

- Clarify the function of EME in typical Queensland pavement designs – CONCEPT
- Collect information about the performance parameters (workability, moisture sensitivity, rutting resistance, stiffness, fatigue resistance) of EME – MIX DESIGN
- Understand the stiffness of EME at different temperatures and loading conditions for QLD – MIX/PAVEMENT DESIGN
- Develop guidelines for the design of heavily-trafficked pavement structures containing EME - PAVEMENT DESIGN

Objectives of the trial

- Construction and production
  - Production control and variability
  - Are low in situ air voids achievable?
  - Material response and comparison curve under Australian compaction equipment
  - Different thicknesses/compactibility
  - Temporary trafficking – is it getting necessary?
  - Amount of tack coat on top of EME

- Pavement design
  - In situ material performance validation
  - Input into mix design/benchmarking/development of tentative specification levels

Pavement instrumentation for validating the design an ongoing performance monitoring

- Weather station funded by AAPA and implemented by ARRB
- The financial contribution from AAPA towards this project is greatly appreciated
- Weather Maestro weather station, manufactured by Environdata, Warwick
- Air temperature sensor, solar radiation sensor, wind, evaporation and six pavement temperature sensors (20-40-80-160-260-360 mm depth)
- Solar power, and remote access via Next G
- Collects data from strain gauges

Volumetric properties

DG20HM mix

EME Class2 mix

Calculation example – QLD demonstration trial

At the time of the pavement design the following assumptions were made:

- DG10 1800 MPa
- DG20HM 2360 MPa
- EME 5400 MPa

Initial notes

- Design is sometimes controlled by subgrade and not asphalt criteria
- The gap in stiffness may be slightly smaller between DG20HM and EME – there is a laboratory program in progress
- Design properties of the thin wearing course will also be validated

Note: GB similar to DG20HM
Source: Delorme, J, Roche, C & Wendling, L 2007, LPC bituminous mixtures design guide, Laboratoire Central des Ponts et Chaussees, Paris, France
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Calculation example – QLD demonstration trial
Pavement thickness according to the Australian method (using the Shell fatigue equation)
Wearing course: 30 mm DG10 asphalt

<table>
<thead>
<tr>
<th>Subgrade property</th>
<th>EME thickness (mm)</th>
<th>DG10 HM thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR 5%</td>
<td>110</td>
<td>160</td>
</tr>
<tr>
<td>CBR 10%</td>
<td>80</td>
<td>130</td>
</tr>
<tr>
<td>CBR 15%</td>
<td>70</td>
<td>110</td>
</tr>
</tbody>
</table>

Pavement thickness according to the French method
Wearing course: 30 mm DG10 asphalt

<table>
<thead>
<tr>
<th>Support category</th>
<th>EME thickness (mm)</th>
<th>GB3 thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF2 (CBR 5%)</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>PF2a (CBR 10%)</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>PF2b (CBR 15%)</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Pavement thickness according to the French method
Wearing course: 30 mm DG10 asphalt

Air temperatures at the time of the trial

![Air temperatures at the time of the trial](image)

Values for demonstration only, as strain gauges are not interfaced yet.

FWD test parameters
- Load: 50 kN on asphalt, 40 kN on granular base
- Wheel path/between wheel paths
- 10 metres, staggered
- FWD test on the asphalt base on 17 February 2014 (morning)
- Surface temperatures 37.6 – 44.9 °C
- FWD data is not temperature corrected

Surface modulus – Eastbound traffic lane
On unbound granular layer (prior to paving)
On asphalt base layer (prior to opening to traffic)

![Surface modulus – Eastbound traffic lane](image)
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The way forward

Monitoring the trial section at Cullen Ave West, Eagle Farm

- Measuring strain responses at known pavement temperatures and loading – input into design validation
- Ongoing FWD measurement at known pavement temperatures – capturing seasonal variation
- Monitoring pavement behaviour with different subgrade bearing capacity
- Back-calculation of in-situ properties – cross validate with laboratory results
- Monitor functional performance, i.e. rutting, RII and surface texture by using the network survey vehicle (NSV)
- Review performance in the light of pavement design and as built properties – we know everything about the pavement structure and the materials

(The hopefully active contribution to the NSW trial, Gerringong, Princes Hwy)

• Install strain gauges, pavement temperature sensors and weather station – financial assistance from AAPA
• Monitor production and construction during the trial and include outcomes into the report
• Ongoing functional and structural performance monitoring under highway traffic

Summary

• Technology transfer
  - Including mix design and pavement design

Validating

• Extensive laboratory testing
• Pavement design case studies
• Production and demonstration trials

Benefit

• Reduction in pavement thickness
• Long term structural performance
• BUT careful implementation is needed

The success of the trial resulted from the collective efforts of every organisation involved

- Boral Asphalt
- SAMI Bitumen
- Brisbane City Council
- AAPA
- TMR
- ARRB project team: Andrew Beecroft, Johnathon Griffin, Erik Denneman
- Special thanks to Xavier Guyot, Technical Manager, COLAS OI-AA-O for his continuous support and help with mix design and pavement design related issues

Surface modulus – Westbound traffic lane
On unbound granular layer (prior to paving)
On asphalt base layer (prior to opening to traffic)