<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 – 9:05</td>
<td>Introduction</td>
<td>Les Marchant</td>
</tr>
<tr>
<td>9:05 – 9:10</td>
<td>WARRIP</td>
<td>Jon Griffin</td>
</tr>
<tr>
<td>9:10 – 9:35</td>
<td>Trial Planning and Mix Design</td>
<td>Willie Valenzuela</td>
</tr>
<tr>
<td>9:35 – 9:50</td>
<td>EME2 Pavement Design</td>
<td>Jon Griffin</td>
</tr>
<tr>
<td>9:50 – 10:00</td>
<td>Questions</td>
<td>All</td>
</tr>
<tr>
<td>10:00 – 10:15</td>
<td>Morning Tea Break</td>
<td></td>
</tr>
<tr>
<td>10:15 – 11:00</td>
<td>Production and Construction</td>
<td>Chris Skantzos</td>
</tr>
<tr>
<td>11:00 – 11:25</td>
<td>Conformance and Research Testing</td>
<td>Steve Halligan</td>
</tr>
<tr>
<td>11:25 – 11:35</td>
<td>What’s Next</td>
<td>Steve Halligan</td>
</tr>
<tr>
<td>11:35 – 11:50</td>
<td>Questions</td>
<td>All</td>
</tr>
<tr>
<td>11:50 – 12:00</td>
<td>Closing Remarks</td>
<td>Les Marchant</td>
</tr>
</tbody>
</table>
Program Objectives

• Conduct **leading research** of road pavements and surfacings, asset management and structures

• **Implementation** of innovative practices that reduce cost and increase rate of return

• Improve specialist **technical capability** in Western Australia

• Contribute to the body-of-knowledge and **collaboration** with other national research programs such as Austroads and NACoE
Current Program (1 of 2)

Pavement Design
• Best practice for major projects - underway
• Cost effective pavement design - underway
• Engineering Road Note 9 Update - underway
• Full-depth asphalt (FDA) temperature profiles - underway
• Asphalt fatigue at elevated temperatures - underway
• Dynamic heavy vehicle loading effects - scope development

Asset Management
• Preliminary trial of traffic speed deflectometer (TSD) - completed
• Australian National Risk Assessment Model (ANRAM) using TSD - underway
• Improved decision making using TSD data - scope development
• Best practice road asset management - scope development
Current Program (2 of 2)

Pavement Technology

- Review of future pavement technologies - completed
- **High modulus asphalt (EME2) - underway**
- Stone mastic asphalt (SMA) - underway
- Crumb-rubber modified open-graded asphalt (OGA) - underway
- Specifications & guidelines for warm-mix asphalt - underway
- Increased reclaimed asphalt pavement (RAP) utilisation - underway
- Review of Tonkin & Reid Hwy trial sections - underway
- Investigation of hydrated cement treated crushed rock base (HCTCRB) trial sections - underway
- Light-emitting lane demarcation - scope development
- Asphalt modification using Nano-technology - scope development
EME2 Workshop
Pre-trial Planning
- Mix Design
- Brisbane
- Site

Willie Valenzuela
EME2
Enrobés á Module Élevé Class 2

- EME2 = high modulus asphalt.
- Mixes are produced using a hard-paving grade bitumen applied at a higher binder content in comparison to the conventional asphalt with unmodified binders.
- High modulus asphalt allows for a significant reduction in pavement thickness.

Properties
- Stiff
- Rut resistant
- Fatigue resistant
- Moisture resistant
- Workability
EME2

Characteristics

- Low air voids content (<6%)
- High binder content (approximately 6%)
- Hard binder: penetration 10-25 pu
- Performance based design
EME2 Mix Design
Specifications Guidelines
# Properties of EME2 Binder

<table>
<thead>
<tr>
<th>Method of test</th>
<th>Unit</th>
<th>Property</th>
<th>EME2 binder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>AS 2341.12</td>
<td>pu (Note 1)</td>
<td>Penetration at 25°C (100g, 5s)</td>
<td>15</td>
</tr>
<tr>
<td>AS 2341.18</td>
<td>°C</td>
<td>Softening point</td>
<td>56</td>
</tr>
<tr>
<td>AS/NZS 2341.2</td>
<td>Pa.s</td>
<td>Viscosity at 60°C (Note 2)</td>
<td>900</td>
</tr>
<tr>
<td>AS/NZS 2341.10</td>
<td>%</td>
<td>Mass change</td>
<td>-</td>
</tr>
<tr>
<td>AS/NZS 2341.10 and AS 2341.12</td>
<td>%</td>
<td>Retained penetration (Note 3)</td>
<td>55</td>
</tr>
<tr>
<td>AS/NZS 2341.10 and AS 2341.18</td>
<td>°C</td>
<td>Increase in softening point after RTFO treatment (Note 4)</td>
<td>-</td>
</tr>
<tr>
<td>AS/NZS 2341.2, AS 2341.3, AS/NZS 2341.4 or AGPT/T111</td>
<td>Pa.s</td>
<td>Viscosity at 135°C</td>
<td>0.6</td>
</tr>
<tr>
<td>AS 2341.8</td>
<td>% mass</td>
<td>Matter insoluble in toluene</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>Penetration index</td>
<td>Report</td>
</tr>
<tr>
<td>AS/NZS 2341.10 and AS/NZS 2341.2</td>
<td>Pa.s</td>
<td>Viscosity at 60°C after RTFO (Note 2)</td>
<td>Report</td>
</tr>
<tr>
<td>AS/NZ 2341.10 and AS/NZS 2341.2</td>
<td>%</td>
<td>Viscosity at 60°C, percentage of original after RTFO treatment</td>
<td>Report</td>
</tr>
</tbody>
</table>
# Aggregate Properties

<table>
<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Abrasion value</td>
<td>35% maximum</td>
<td>WA220.1</td>
</tr>
<tr>
<td>Flakiness Index</td>
<td>25% maximum</td>
<td>WA 216.1</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>2% maximum</td>
<td>AS 1141.6.1</td>
</tr>
<tr>
<td>Wet strength</td>
<td>100 kN minimum</td>
<td>AS 1141.22</td>
</tr>
<tr>
<td>Wet/dry strength variation</td>
<td>35% maximum</td>
<td>AS1141.22</td>
</tr>
<tr>
<td>Degradation Factor</td>
<td>50% minimum</td>
<td>AS 1141.25.2</td>
</tr>
<tr>
<td>Petrographic examination</td>
<td>Statement of suitability for use as an asphalt aggregate</td>
<td></td>
</tr>
</tbody>
</table>
## Requirements of the combined filler

<table>
<thead>
<tr>
<th>Method of test</th>
<th>Unit</th>
<th>Property</th>
<th>Mineral filler</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 1141.17</td>
<td>%</td>
<td>Voids in dry compacted filler</td>
<td>Min: 28, Max: 45</td>
</tr>
<tr>
<td>EN 13179–1: 2000 (Note2) and AS 2341.18</td>
<td>°C</td>
<td>Delta ring and ball (Note 1)</td>
<td>Min: 8, Max: 16</td>
</tr>
</tbody>
</table>
Mix design criteria of EME2

<table>
<thead>
<tr>
<th>Property</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air voids in specimens compacted by gyratory compactor at 100 cycles</td>
<td>–</td>
<td>6.0%</td>
</tr>
<tr>
<td>Stripping potential of asphalt – tensile strength ratio</td>
<td>80%</td>
<td>–</td>
</tr>
<tr>
<td>Wheel tracking at 60°C and 30,000 cycles (60,000 passes)</td>
<td>–</td>
<td>4.0mm</td>
</tr>
<tr>
<td>Wheel tracking at 60°C and 5,000 cycles (10,000 passes)</td>
<td>-</td>
<td>2.0mm</td>
</tr>
<tr>
<td>Flexural stiffness at 50 ± 3 με, 15°C and 10 Hz</td>
<td>14,000MPa</td>
<td>–</td>
</tr>
<tr>
<td>Fatigue resistance at 20°C, 10 Hz and 1 million cycles</td>
<td>150 με</td>
<td>–</td>
</tr>
<tr>
<td>Richness modulus</td>
<td>3.4</td>
<td>–</td>
</tr>
</tbody>
</table>

Specimens shall be compacted to an air void content of 1.5 – 4.5% (SDD)
EME2 Mix Design Process

- Resilient Modulus
- Tensile Strength Ratio
- Fatigue Resistance
- Wheel tracking

Flexural Stiffness
EME2 Wheel tracking results

Proportional rut depth (%) vs. Number of passes/cycles
EME2 Modulus Master Curve

\[ E^* \text{ [MPa]} \]

\[ \text{Frequency [Hz]} \]
EME2 Mix Design Validation

Properties to be tested by European Laboratory

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Note</th>
<th>Limit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air voids in specimens compacted by gyratory compactor at 100 gyratory cycles</td>
<td>EN 12697-31</td>
<td></td>
<td>Maximum</td>
<td>6%</td>
</tr>
<tr>
<td>Water sensitivity</td>
<td>EN 12697-12</td>
<td></td>
<td>Minimum</td>
<td>70%</td>
</tr>
<tr>
<td>Wheel tracking at 60 °C and 30 000 cycles(^{(1)})</td>
<td>EN 12697-22</td>
<td>Large size device, 2 slabs</td>
<td>Maximum</td>
<td>7.5%</td>
</tr>
<tr>
<td>Minimum stiffness modulus at 15 °C and 10 Hz(^{(1)})</td>
<td>EN 12697-26 Method A</td>
<td>Two point bending trapezoidal specimens</td>
<td>Minimum</td>
<td>14 000 MPa</td>
</tr>
<tr>
<td>Fatigue resistance at 10 °C, 25 Hz and 10(^6) cycles(^{(1)})</td>
<td>EN 12697-24 Method A</td>
<td>Two point bending trapezoidal specimens 3 strain levels, 6 specimens for each strain level</td>
<td>Minimum</td>
<td>130 με</td>
</tr>
</tbody>
</table>

Specimens shall be compacted to an air void content of 3–6% (mensuration).
EME2 Brisbane Trial - March 2017

Location
EME2 mix was placed on Gateway North on the Brisbane outskirts.

Pavement Composition
- 160 mm thick layer of unbound granular material treated with a cementitious stabilising agent. Sealed with CRS 60 emulsion with 10 mm aggregate.
- EME2 base layer design thickness was 110 mm. Placed in one layer on top of the working platform seal.

Mix Design
- EME2 trial mix design was prepared by Boral and verified by TMR.
EME2 Brisbane Trial
EME2 Brisbane Trial

Full Pavement Thickness

- Subgrade (design CBR 7%)
- 160mm improved layer unbound granular material
- 10mm Primer seal
- 110mm EME2 asphalt (placed in 1 layer)
- 50mm DG14HS asphalt
- Seal 10mm PMB
- 50mm SMA 14 asphalt

Production

- EME2 mix production: 100 tonnes per hour, with a total of approximately 700 tonnes with a production temperature between 180º C and 190ºC.
- Paving took place in a northbound direction in one single layer.
EME2 Brisbane Trial

Placement

• A material transfer vehicle (MTV) was used to received the asphalt mix from the trucks and remix it before depositing it into the hopper of the paver.

• Advantages of using an MTV include:
  – Prevents trucks from bumping the paver resulting in an uneven compacted surface.
  – Increasing the material buffer available to the paving operation, which could improve the continuity of the paving process.
  – Remixing the material preventing heat segregation and therefore, improving homogeneity of compaction.
EME2 Brisbane Trial
EME2 Brisbane Trial

• During the trial several different tests were performed to ensure quality control. TMR mix requirements for daily routine of testing consist of four test:
  • Particle size distribution
  • Binder content
  • Maximum density
  • Compaction tests
EME2 Brisbane Trial

EME2 Finished Surface
EME2 Brisbane Trial

Learned Knowledge

- For any project, additional emphasis should be placed on the importance of not exceeding the maximum production temperature of 190°C.
- EME2 is a mix with a high dust percentage (±40%) therefore extreme care should be taken with the dust moisture content as this could affect achieving the desired production temperature. A good practice should cover the dust especially during the wet season.
EME2 Perth Trial Location

- EME2 mix was placed on the new southbound right turn pocket on Tonkin Highway with Kelvin Road Orange Grove WA 6109. The geographic coordinates for the trial section are: 32°01’46.4”S 116°00’22.1”E.
EME2 Perth Trial Location
EME2 Perth Trial Location
Thank you
EME2 Pre-trial Pavement Design

- Pavement design concepts
- High modulus asphalt (EME2)
- Performance-based asphalt design
- Interim design approach
Pavement Design Concepts

- Minimise subgrade vertical compressive stress/strain
- Limit horizontal tensile strain in bound layers
- Manage the development of horizontal shear stress

Source: Du, Shen & Cross (2008)
Pavement Design Concepts

- Material modulus
- Layer thickness
High Modulus Asphalt (EME2)

- Enrobés à module élevé “asphalt with an elevated modulus”
- French technology developed in mid-1970s
- High performance structural asphalt for heavy-duty pavements
- High rut resistance → incorporates hard grade bitumen
- High fatigue resistance → richness modulus > 3.4
Performance-based Asphalt Design

- Mechanistic structural design approach incorporating mix specific characteristics

Source: Dupuy (2017)
Performance-based Asphalt Design

• Mechanistic structural design approach incorporating mix specific characteristics

<table>
<thead>
<tr>
<th>Performance Characteristic</th>
<th>Test Method</th>
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<tbody>
<tr>
<td>Air voids in specimens compacted by gyratory compactor at 100 cycles</td>
<td>AS/NZS 2891.8</td>
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<tr>
<td>Stripping potential of asphalt – tensile strength ratio</td>
<td>AG:PT/T232</td>
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<tr>
<td>Wheel tracking at 60°C and 30,000 cycles (60,000 passes)</td>
<td>AG:PT/231</td>
</tr>
<tr>
<td>Wheel tracking at 60°C and 5,000 cycles (10,000 passes)</td>
<td>AG:PT/231</td>
</tr>
<tr>
<td>Flexural stiffness at 50 ± 3 µε, 15°C and 10 Hz</td>
<td>AG:PT/T274</td>
</tr>
<tr>
<td>Fatigue resistance at 20°C, 10 Hz and 1 million cycles</td>
<td>AG:PT/T274</td>
</tr>
<tr>
<td>Richness modulus</td>
<td>ERN13 (draft) Section 4</td>
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</table>
Interim Design Approach

• Compatible with existing Austroads mechanistic design procedure

<table>
<thead>
<tr>
<th>Design speed (kph)</th>
<th>WMA PT (°C)</th>
<th>Binder Volume (%)</th>
<th>Design Modulus (MPa)</th>
<th>Parameter - k</th>
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</thead>
<tbody>
<tr>
<td>90</td>
<td>29</td>
<td>13.5</td>
<td>5 500</td>
<td>3921</td>
</tr>
<tr>
<td>80</td>
<td>29</td>
<td>13.5</td>
<td>5 300</td>
<td>3989</td>
</tr>
<tr>
<td>60</td>
<td>29</td>
<td>13.5</td>
<td>4 800</td>
<td>4134</td>
</tr>
<tr>
<td>50</td>
<td>29</td>
<td>13.5</td>
<td>4 500</td>
<td>4231</td>
</tr>
<tr>
<td>30</td>
<td>29</td>
<td>13.5</td>
<td>3 800</td>
<td>4496</td>
</tr>
<tr>
<td>10</td>
<td>29</td>
<td>13.5</td>
<td>2 500</td>
<td>5228</td>
</tr>
<tr>
<td>Site Conditions</td>
<td>Design Parameters</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WMAPT (°C)</td>
<td>29</td>
<td></td>
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<tr>
<td>Design traffic (ESA)</td>
<td>3.8 * 10^7</td>
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<tr>
<td>Heavy vehicle speed (kph)</td>
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<td></td>
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<tr>
<td>SAR5/ESA</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Design Subgrade CBR (%)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SAR7/ESA</td>
<td>1.64</td>
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<tr>
<td>Design period (years)</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reliability (%)</td>
<td>95</td>
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<table>
<thead>
<tr>
<th>Wearing course</th>
<th>14 mm intersection mix</th>
<th>40</th>
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</thead>
<tbody>
<tr>
<td>Waterproofing seal</td>
<td>14 mm intermediate</td>
<td>50</td>
</tr>
<tr>
<td>Wearing course</td>
<td>14 mm intersection mix</td>
<td>50</td>
</tr>
<tr>
<td>Base course</td>
<td>20 mm intermediate</td>
<td>220</td>
</tr>
<tr>
<td>Subbase</td>
<td>Limestone</td>
<td>150</td>
</tr>
<tr>
<td>Subgrade</td>
<td>Sand</td>
<td>∞</td>
</tr>
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</table>

- Traditional pavement = 460 mm
- High modulus pavement = 410 mm
<table>
<thead>
<tr>
<th>Site Conditions</th>
<th>Design Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMAPI (°C)</td>
<td>29</td>
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<td>Design traffic (ESA)</td>
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<td>Heavy vehicle speed (kph)</td>
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<td>SAR5/ESA</td>
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<td>Design Subgrade CBR (%)</td>
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<tr>
<td>SAR7/ESA</td>
<td>1.64</td>
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<tr>
<td>Design period (years)</td>
<td>40</td>
</tr>
<tr>
<td>Reliability (%)</td>
<td>95</td>
</tr>
</tbody>
</table>

| Wearing course                  |                   |
| 10 mm open grade                | 30                |
| 10 mm dense grade               | 40                |

| Waterproofing seal              | Wearing course    |
| 14 mm intermediate              | 50                |
| 20 mm intermediate              | 190               |

| Base course                     |                   |
| 14 mm EME2                      | 185               |
| Subbase                         |                   |
| Limestone                       | 150               |

| Subgrade                        |                   |
| Sand                            | ∞                 |

Traditional pavement = 460 mm
High modulus pavement = 405 mm
References

- Main Roads Western Australia, Draft, *High Modulus Asphalt (EME2) Mix Design*, Engineering Road Note 13, Government of Western Australia.
EME2 Workshop
Production and Construction of EME2 Trial
Mix Details

• Enrobés à Module Élevé Class 2 (EME2)
• Produced : Downer Asphalt Plant - Gosnells
• Aggregate : Holcim Granite to Specification 511- Gosnells
• Bitumen : SAMI – Produced in Brisbane 15/25 Pen
• A Production and Placement trial only
• Tonkin/Kelvin Intersection Turning Pockets
Plant Production

• Just like a Normal Asphalt mix with tighter controls
  Heating of binder lines prior to 15/20 Pen
  – Extended preheating and extended shutdown times
  – Running mix with other binder or aggregates to heat plant
  – Production rate comfortable at 75% max production (100 t/h)
  – Batching temperature in Draft Specification 514
    tolerance ranging between 175°C-190°C
Plant Production

- 3 semi trailers of 15/25 Pen for the yard trial and 2 days site trial
- 0.3% adhesion agent for trial production at SAMI
- Direct feed of binder from tankers to plant
Plant Sampling - Bitumen

- Very important for EME2 asphalt
- 2 sample increments for 100 ton yard trial
- 3 sample increments per day per tanker, targeted at:
  - 5000 L
  - 10000 L
  - 15000 L
- On transfer during production
Plant Sampling - Asphalt

- Production testing
  - PSD
  - Binder Content
  - Max Density, and
  - Production Moisture

- No laboratory compaction testing...yes not even Marshalls
Plant Sampling - Asphalt

- Bulk Sample for performance testing off site
  - Workability - 100 cycle gyratory
  - Tensile Stripping Ratio
  - Resilient Modulus
  - Wheel Tracking
  - Flexural Stiffness @15°C (Beam Modulus)
  - Beam Fatigue Testing
  - Hamburg Wheel Tracker Testing
Transportation

Pros

• Under 6.0km from the Downer Asphalt Yard exit to Site
• Low amount of heat loss
  – Covered trucks
  – Short distance
  – Good climatic conditions
Transportation

Cons

• Waiting for trucks
  – Close Distance
  – Direct Blending
  – Improved day 2 with additional trucks
Subbase

- Subbase Levels were good and in Specification
Subbase

- Subbase quality was variable
  - Spalled areas
  - Late cutting
- Not Primed
  - Binder Logistics
  - Rain
  - Dryback
  - WE WANT PRIMED SUBBASE!!
Construction

- 26 and 27 of April 2017
- 26.1°C and 26.7°C days, low wind, sunny, no rain
- 2 layers of 14mm EME2
- 210mm thick (2@105mm)
- 2 x 3.5m wide turning pockets
- One edge against existing basecourse
- One side unconfined
- One hot joint
- 100t yard trial, 1000t over 2 days.
Expertise

- French
  - Monsieur Pierrick Dupuy
  - Reunion Island
  - Had no issues with our processes
- Downer Infrastructure Services
  - Eric Clauss
  - Project Manager
  - EME2 experience
Placement

- Paver tamper set to medium
- Preheating of screed
- Bulking factor 25% loose
Mix Temperature

• Mix in truck at plant
  – Within Draft Specification 514
  – Probe - 169°C – 183°C
• Mix Delivery to site
  – Within Draft Specification 514
  – Probe - 162°C – 180°C
• Back of Paver
  – Infrared - Typically 135°C-155°C
  – Probe Internal – Typically 150°C+
Mix Temperature
Compaction

- Order of rollers
  - Steel Drum,
    - 9 ton, 2 passes static, 3 passes medium vibe
  - Multi rubber tyre
    - 14 ton, 4-6 passes
  - Steel Drum
    - 7 ton, 4 static passes
Compaction

- Rollers as close to paver as possible
- Overlapping of all 3 rollers
Compaction

- Indent from first roller pass
Compaction

- Marks from Rollers
Joints

- Critical for EME2 asphalt
- Cutting, and Pressing of Joints
- Tacking joint edge
- Overlapping joint
- Butting up, rolling and pressing of joints not throwing mix
Joints

- Cut
Joints

- Cut
- Clean
Joints

- Cut
- Clean, and
- Press
Joint Overlapping

• 2 Techniques
  – “Standard Practice” racking and flicking edge
  – Butting up, rolling and pressing of joints
Joint Overlapping
Compacting Joints

- Overhang one steel roller
- Compact over rolled joint
Joint Temperature
Finished Joints

What Joint???????????
EME2 Levels

EME2 Layer 1 (LR1 & LR2)

EME2 Layer 2 (LR1 & LR2)
Surface Finish

- Similar to a 10mm DGA
Surface Finish

- Flush patches
- No issue
Tack coating

- Didn’t meet requirements of Specification
  - Streaking/tram tracked
  - Not even
  - Applied with works truck
- Has been rectified and truck now sprays evenly
Density Testing

• Conformance - Cores to AS2891.2
• Standard Specification 201 frequency
• Research - Nuclear Thin Layer Gauge
• Site compaction Indication – Downer Pavement Quality Indicator
Wearing course

- No Seal
- Tack coated
- 50mm of 14mm Intersection Mix with A15E PMB
Lessons Learnt

• Just Like Normal Asphalt
• Vertical tank for Binder
• Pickup grid should occur more frequent for levelling software (5m)
• Increase of loose bulking factor
• Tight compaction train
• Rollers Overlapping
• Temperature control of whole process
• Coring next day
Lessons Learnt

- Rollers off if too hot and mobile
- Roller tyres to be wet
- Don’t leave roller stationary on mat
- Multi to have skirts
- Joints are critical
  - Offset roller so one drum is overhanging unsupported edge
  - Cutting of joints as per Specification 510/Draft Specification 514
  - Overlapping of joints as per Specification 510/Draft Specification 514,
  - Butting up, rolling and pressing of joints not throwing mix
Thanks

- Downer
- SAMI
- ARRB
- Main Roads Laboratory Staff
- Main Roads Contract team on Tonkin/Kelvin
- Pierrick Dupuy
- WBHO
Questions

• Please have a think and ask any questions at the end of all presentations
EME2 Workshop
Binder, Mix and In-situ Properties of EME2
<table>
<thead>
<tr>
<th>Property</th>
<th>Variation from Target</th>
<th>Property</th>
<th>Variation from Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder Content</td>
<td>- 0.1 to +0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSD Passing 13.2</td>
<td>- 3 to +1</td>
<td>PSD Passing 13.2</td>
<td>-1 to +2</td>
</tr>
<tr>
<td>9.5</td>
<td>- 6 to +1</td>
<td>0.6</td>
<td>-0.9 to +1.7</td>
</tr>
<tr>
<td>6.7</td>
<td>-5 to +6</td>
<td>0.3</td>
<td>-0.6 to +1.7</td>
</tr>
<tr>
<td>4.75</td>
<td>-5 to +3</td>
<td>0.15</td>
<td>-0.7 to +1.1</td>
</tr>
<tr>
<td>2.36</td>
<td>-2 to +3</td>
<td>0.075</td>
<td>-0.7 to +0.8</td>
</tr>
</tbody>
</table>
Mix Properties #2

- Particle Coating 100%
- Moisture Content 0% and 0.1%
- Maximum Density 2.483 to 2.499 t/m³
- Air Voids after 100 cycles gyratory compactor were 3.0% and 3.2% (Limit ≤ 6.0%)
Binder Samples #1

- Pre-trial 12/4 - 2 samples, 1 full test
- Trial 26/4 – 6 samples, 3 full tests
- Trial 27/4 – 6 samples, 3 full tests
# Binder Samples #2

<table>
<thead>
<tr>
<th>Date</th>
<th>V60</th>
<th>V135</th>
<th>Pen</th>
<th>SP</th>
<th>V60 after RTFO</th>
<th>SP after RTFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/4</td>
<td>14781</td>
<td>2.69</td>
<td>18</td>
<td>73</td>
<td>47924</td>
<td>78.5</td>
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<tr>
<td>26/4 am</td>
<td>11019</td>
<td>2.52</td>
<td>19</td>
<td>71</td>
<td>40549</td>
<td>77.5</td>
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<tr>
<td>26/4 pm</td>
<td>10477</td>
<td>2.45</td>
<td>20</td>
<td>71</td>
<td>44074</td>
<td>78</td>
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<tr>
<td>27/4 am</td>
<td>10025</td>
<td>2.31</td>
<td>19</td>
<td>70.5</td>
<td>34444</td>
<td>76.5</td>
</tr>
<tr>
<td>27/4 pm</td>
<td>5802</td>
<td>1.87</td>
<td>22</td>
<td>67.5</td>
<td>34827</td>
<td>77</td>
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## Filler

<table>
<thead>
<tr>
<th>Property</th>
<th>Results</th>
<th>Limits</th>
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<tbody>
<tr>
<td>Voids in dry compacted filler</td>
<td>33 %</td>
<td>28 – 45</td>
</tr>
<tr>
<td>Softening point supplied bitumen</td>
<td>72.5 °C</td>
<td>56 - 72</td>
</tr>
<tr>
<td>Softening point mastic (bitumen + filler)</td>
<td>76.0 °C</td>
<td></td>
</tr>
<tr>
<td>Delta ring &amp; ball</td>
<td>3.5</td>
<td>8 - 16</td>
</tr>
</tbody>
</table>
In-situ Properties

Air Voids % Layer 1

| Layer 1 | 2.7 | 3.7 |

Air Voids %
In-situ Properties

Air Voids % Layer 2

Air Voids %

Layer 2

- In-situ Air Voids %

4.1

3.3

- Graph showing in-situ air voids for Layer 2 with values 4.1 and 3.3.
Voids Top and Bottom Half - Layer 2

Air Voids % Top Half

Air Voids % Bottom Half
Performance Tests – Moisture Sensitivity

Average Tensile Strength - Pretrial

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tensile Strength</th>
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</thead>
<tbody>
<tr>
<td>Dry</td>
<td>1250</td>
</tr>
<tr>
<td>Wet</td>
<td>1375</td>
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</tbody>
</table>
Performance Tests – Moisture Sensitivity

Average Strength - Day 1

Dry: 1462
Wet: 1465.5
Performance Tests – Moisture Sensitivity

Average Strength - Day 2

Tensile Strength

Dry  Wet
# Rutting Data

<table>
<thead>
<tr>
<th></th>
<th>10,000 Passes</th>
<th>60,000 Passes</th>
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</thead>
<tbody>
<tr>
<td><strong>Maximum Limit</strong></td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Specimen 1</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Specimen 2</td>
<td>0.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Stiffness vs Voids

Siffness Modulus vs Air Voids by SSD

$R^2 = 0.9957$
Fatigue Resistance at 20°C

\[ y = 1167x^{-0.135} \]

\[ R^2 = 0.899 \]
Lessons

- Handling and Storage of binder
- Construction of Joints
- Specification of Stiffness
- Measurement of Filler Stiffness
Northlink Stage 1

As per SWTC

<table>
<thead>
<tr>
<th>30mm</th>
<th>40mm</th>
<th>50mm</th>
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<tbody>
<tr>
<td>OGA</td>
<td>10 DGA</td>
<td>14 DGA</td>
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<tr>
<td></td>
<td>20 DGA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>190mm</td>
<td>145mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>185mm</td>
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Section

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
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</table>

Bridge 1770 Northern abutment
<table>
<thead>
<tr>
<th>Section</th>
<th></th>
<th>As per SWTC</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Bridge</td>
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<td></td>
</tr>
<tr>
<td>Bridge 1771 South abutment</td>
<td>2700</td>
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</tr>
</tbody>
</table>
Where Next with EME Pavements?

- Northlink Stage 2
- Kwinana Freeway widening
- Mitchell Freeway widening
- Roe Hwy / Kalamunda
- Specification and Design
EME2 Workshop

QUESTIONS

AN INITIATIVE BY: