Operational behaviour and Performance of Laboratory and Field produced WMA Asphalt

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Outline

• Introduction
• Research Methodology
• Background Study
• Empirical testing program
• Implications for paving industry
• Future research
• Conclusions
Introduction

Why reducing AC production temperatures?

- Energy consumption
- CO2 emission,
- Aging of binder,
- Fumes, odour,
- Costs.
Research Methodology

• A literature review → options to produce asphalt
• Lab samples and testing them,
  ➢ to test mixing procedures, and,
  ➢ performance;
• Full scale field test sections,
  ➢ test moments of adding additive, and,
  ➢ make field produced asphalt samples;
• Testing the mechanical properties of;
  ➢ full size samples from the field studies.
Background Study

Reducing production temperature HMA Asphalt

• From: normal production temperatures HMA: 160 - 180°C, to,
• Making WMA: Reducing temperatures with about 30 to 50°C

3 categories:
• Organic additives,
• Foaming,
• Chemical additives.
Background Study

Different possibilities of making WMA:

• Organic additives:
  • Viscosity reduction,
  • Examples: Sasobit, Fisher-Tropsch wax, Ecoflex etc.
  • Take care about melting point related to in-service temperature.

• Foamed Bitumen
  • Injection of water, or,
  • Use of a Zeolith.

• Chemical additives
  • Chemical additives pre-mixed into bitumen.
Empirical testing program

Different possibilities tested in the laboratory:

• Cecabase and Rediset WMX (both chemical additives),
• Advera and Aspha-Min (both Zeolites),
• Sasobit (wax).

Considerations:

• Maturity of the products,
• Flexibility: producing 2 products at 1 plant (fi. HMA & WMA),
• The expected performance,
• Costs.
Empirical testing program

Testing workability by making Marshall samples and deduce HR %

<table>
<thead>
<tr>
<th>Voids % results WMA Advera AC 11 Surf compared to HMA AC 11 Surf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>AC 11 Surf (a)</td>
</tr>
<tr>
<td>AC 16 Base (b)</td>
</tr>
<tr>
<td>AC 16 Base II (c)</td>
</tr>
</tbody>
</table>
Empirical testing program

Testing ITS dry and retained, deduction of water susceptibility
Empirical testing program

Testing ITS dry and retained, deduction of water susceptibility

Levels: not equal

Equal Mixes
Empirical testing program

Results lab testing (ii)

– Advera lab samples perform sometimes better sometimes worse,

– Preparing small amounts of WMA (lab) using a Zeolite does not always simulate performance truly.

However:

– Good Results Advera (USA > 300.000 tonne)

– Good Results Aspha-min (Germany over 8 yr exp)
Empirical testing program

Full scale tests:

Set up of the pilot: Testing ......

- Dense surface & base course materials 0/11 & 0/16,
- Different moments of dosing the Advera,
- Mixtures without RAP,
- Mixtures with 30 and 50% RAP,
- Production temperatures 130 - 135 °C.
Empirical testing program

Full scale test sections data logging environment (ASPARi) as reported at Mairepav6 (ter Huerne et al).

Compaction diagram; # passes

Surface temperature behind the screed
16.10 - 16.38 uur

Laydown Temp °C

Temp & density progression
Empirical testing program

From full scale test sections:
- Samples, 4 point bending beam, & dynamic tri-axial testing (rutting), results:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HMA-AC 16</th>
<th>WMA-Advera AC 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/m³)</td>
<td>2387</td>
<td>2398</td>
</tr>
<tr>
<td>Stiffness (E* in MPa)</td>
<td>7940</td>
<td>8007</td>
</tr>
<tr>
<td>Fatigue (ε₆ in µm/m)</td>
<td>115.6</td>
<td>122.2</td>
</tr>
<tr>
<td>Rutting (fₖ in µm/m/pulse)</td>
<td>0.34</td>
<td>0.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HMA-AC 22 50% RAP</th>
<th>WMA-Advera AC 22 50% RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/m³)</td>
<td>2405</td>
<td>2437</td>
</tr>
<tr>
<td>Stiffness (E* in MPa)</td>
<td>9333</td>
<td>9544</td>
</tr>
<tr>
<td>Fatigue (ε₆ in µm/m)</td>
<td>126.0</td>
<td>118.3</td>
</tr>
<tr>
<td>Rutting (fₖ in µm/m/pulse)</td>
<td>0.2</td>
<td>0.46</td>
</tr>
</tbody>
</table>

With and without RAP ➔ good results
Empirical testing program

Result Drum mixed AC samples:

- Compaction tests at different temperatures (Marshall samples):

<table>
<thead>
<tr>
<th>Compaction at temperature…</th>
<th>Voids percentage [%]</th>
<th>ITSР [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>120°C</td>
<td>4.3</td>
<td>57</td>
</tr>
<tr>
<td>95°C</td>
<td>6.0</td>
<td>79</td>
</tr>
<tr>
<td>70°C</td>
<td>8.8</td>
<td>89</td>
</tr>
</tbody>
</table>

Until 95 °C  good workability of the Advera WMA mix
Implications for Paving Industry

• Paving at lower temperatures →
  – Less fumes and odours,
  – Less aging of the bitumen during production
• Compaction process at lower temperatures, possible shorter compaction windows,
• Less energy consumption and less (Co2) emission,

Investment needed in:
• Equipment
• Knowledge
• Operational experience
Future Research

Aspects WMA /Advera is unknown further investigations will be done after: . . .

• Effects of the lower temperatures on the compaction processes,

• Effects compaction temperatures on specifications of WMA, and,

• Operational handling of mixtures during paving (physical intensity).
Conclusions

The following conclusions could be drawn:

– WMA-Advera performs as good as regular HMA mixtures,
– During the lab and field experiments we considered and compared:
  ➢ Indirect tensile strength (dry and retained)
  ➢ Stiffness & Fatigue (4 point bending)
  ➢ Resistance against Rutting,

We also studied production of the mix,

– The process of mixing in the Advera is not very vulnerable for the moment of adding the Advera,

Field pilot indicated not much differences between operational behaviour of WMA-Advera vs. HMA.

Linescanners and GPS technology proved to be helpful to monitor the process carefully.
Questions?