Binder and mix evaluation of highly modified bitumen

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Motto: Po asfaltových vozovkách k černým zítřkům
Background

Pavement preservation systems can address key challenge for asset management of mature road network

European vision towards circular economy encourages whole life cycle approach including end of life

High performance asphalt mixes, such EME* type, provide long lasting, optimised pavement design

SBS modified bitumen has shown proven benefits in surface layers and can find value in structural layers

Full evaluation of asphalt with highly modified bitumen for modern and smart asphalt pavement

* Enrobés à Module Elevé
HiMA concept

Highly Modified Asphaltic binder

Balance between asphaltenes and polymer phases

- SBS in bitumen expands by 7-10 times in volume
- HiMA achieved with 7-8% SBS
- Denser polymer network for rutting and cracking resistance

Advantages for structural layer
The path to HiMA

With standard SBS polymer, the higher the SBS content, the higher the viscosity is

Mitigate potential high viscosity with tailored high vinyl di-block SBS (D0243)

- Easy dissolving, low shear often sufficient
- High compatibility with various bitumen types
- Suitable for modification of hard bitumen
- Improved aging resistance

Binder and mix evaluation of highly modified bitumen
Experimental plan

Comparing BBME* type mix with HiMA mix
  ➤ BBME* with hard binder 20/30 and 25% RA**
  ➤ Asphalt Concrete, AC***16, with HiMA binder and 25% RA**

Binder evaluation
  ➤ Conventional properties including aging
  ➤ More fundamental rheology properties

Mix evaluation
  ➤ Mechanical characteristics, rutting, modulus, cracking susceptibility
  ➤ Binder recovery and further evaluation

* Béton Bitumineux à Module Elevé, **Reclaimed Asphalt, ***Asphalt Concrete
Binder characterisation

Based on penetration value at 25°C and softening point temperature

- HiMA binder achieve high softening point > 80°C and still reasonable penetration value
- High temperature interval (delta in softening point vs Fraass)
Binder aging

Binder lab aging

- Short-term aging with RTFOT
- Long-term aging with PAV

Less changes in properties for the HiMA binder
Binder rheology, fundamental properties

**Dynamic Shear Rheometer**
- Wide range of temperatures

**Bending Beam Rheometer**
- At low temperature, creep stiffness and relaxation
Asphalt mix

Asphalt mixes with 25% Reclaimed Asphalt, RA

- BBME with higher binder content 5.4% and filler 8%

<table>
<thead>
<tr>
<th>Mix</th>
<th>Binder</th>
<th>RA</th>
<th>Binder content</th>
<th>Void content</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBME</td>
<td>20/30</td>
<td>25%</td>
<td>5.4%</td>
<td>2 - 4%</td>
</tr>
<tr>
<td>AC 16 HiMA</td>
<td>HiMA</td>
<td>25%</td>
<td>4.8%</td>
<td>5 - 7%</td>
</tr>
</tbody>
</table>

Compactability via gyratory compaction

- Much lower void content with BBME
Asphalt mix mechanical characterisation

Rutting resistance (EN 12697-26)
- BBME slightly higher rutting depth

Modulus 4PT (EN 12697-26)
- BBME → very high modulus due to RA
- HiMA re-balanced modulus in specification

<table>
<thead>
<tr>
<th>Material</th>
<th>Modulus 15°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
<td>12 000 MPa</td>
</tr>
<tr>
<td>BBME 20/30</td>
<td>17 500 MPa</td>
</tr>
<tr>
<td>AC 16 HiMA</td>
<td>12 600 MPa</td>
</tr>
</tbody>
</table>
Additional mix testing

Cracking susceptibility through restrained cooling test

- Ability to withstand thermal shrinkage
- HiMA mix shows better cracking resistance

![Graph showing cracking susceptibility through restrained cooling test](image)
Thin overlay – Kalety Poland 2013

First project in Poland on secondary road
Pavement at the end of its life with severe distresses
Thin overlay 2.5-3 cm SMA 5 DSH with HiMA 65/105-80
No cracking even after 5 years
Conclusion

Use of balanced mix design to evaluate asphalt materials
HiMA in structural asphalt layer can meet EME type specification
➤ No need for higher binder content as for EME mix type
Enable the use of Reclaimed Asphalt without adverse effect
Better cracking resistance
Already track records in Eastern Europe
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