LOW TEMPERATURE ASPHALT (WMA)
IN SWEDEN

Presented by
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Presentation of a on-going project in Sweden
Swedish definition of WMA

- Production temperature above 120 °C (248 °F)
- Requirements (Quality) the same as ordinary Hot-mix
24 km new motorway
E4 Enånger-Hudiksvall
Where is it?
Where is it?
New motorway
E4 Enånger-Hudiksvall

- 24.5 km (15.2 miles)
- Four lanes
- Speed limit 110 km/h (68 miles/h)
- Traffic 7500 YDT
- Heavy traffic (>3.5 tons) 23%
- Studded tyres 65%
## Pavement design – slow lane

<table>
<thead>
<tr>
<th>Course</th>
<th>Thickness (mm)</th>
<th>Thickness (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearing course</td>
<td>35 mm</td>
<td>1.38 in</td>
</tr>
<tr>
<td>SMA 11 (0.63 in)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Binder course</td>
<td>50 mm</td>
<td>1.97 in</td>
</tr>
<tr>
<td>AC 16 (0.63 in) (^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base course</td>
<td>86 mm</td>
<td>3.39 in</td>
</tr>
<tr>
<td>AC 32 (1.26 in)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unbound base</td>
<td>80 mm</td>
<td>3.15 in</td>
</tr>
<tr>
<td>0-32 mm (0-1.26 in)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unbound sub base</td>
<td>600 mm</td>
<td>23.6 in</td>
</tr>
<tr>
<td>0-100 mm (0-3.94 in)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total asphalt production and RAP

- In all 141,000 tons
  - Wearing course 36,000 tons - RAP 5%
  - Binder course 29,000 tons - RAP 20%
  - Base course 76,000 tons - RAP 30%
  - 124,000 tons WMA and 17,000 tons Hot-mix
Moisture left in the mix?

- Normal Hot-mix production above 150 °C (302 °F) for two reasons:
  - a) to have a viscosity of the binder that makes it soft enough to cover the aggregate easily and
  - b) to dry the aggregate so no moisture is left
- If the aggregate is heated to no more than 120-130 °C (248-266 °F) there is no really guarantee that all moisture has been removed, which makes this one important challenge for the WMA technique
Moisture and RAP

- Dry the aggregate at a temperature over 150 °C (302 °F), add unheated RAP so that the mixed components end up with a temperature of 120-130 °C (248-266 °F)
- Adding RAP makes it easier to produce WMA where the aggregate has been fully dried
- The RAP itself contains some moisture, it is important to keep this as low as possible: < 2%
- Even so there will be some moisture left: about 0.1%, this is handled by adding a little more of an anti-stripping agent
Keep the RAP dry
Start in the Laboratory

- **Materials**
  - Bitumen
    - Pen 100/150, 160/220
  - Aggregate
    - Special requirements for wearing course
  - RAP
  - Anti-stripping agent (Very important)
Start in the Laboratory

• Mixes
  • Workability of the mix.
  • Mechanical characteristics
    o Resistance to deformation
    o Stiffness
    o Water sensitivity
    o Resistance to abrasion against studded tires
Laboratory test methods

Workability test
Laboratory test methods

Resistance against deformation

Uniaxial cyclic compression test (EN 12697-25 part A)
Laboratory test methods

Stiffness

(EN 12697-26 part C)
Indirect tensile test
Laboratory test methods

Resistance against abrasion Prall (EN 12697-16 part A)

Water sensitivity Indirect Tensile test (EN 12697-12 part A)
Asphalt plant – Astec Double Barrel (1994) Refurbished for WMA
WMA-technique

The process is based on foam-technique.
But also other important changes in the production process concerning where and when the different components are added
To make the mix less sensitive to water a fluid anti-stripping agent is added (a little more than normal)
The same principal technique is used in batch-plants at other sites
Shuttle-Buggy
Pre-trials HMA and WMA with full test program
Production control

- Control of production temperature at asphalt plant
  (continuously monitored) - within the stipulated limits 120-130 C (248-266 F)

- Production control at the asphalt plant
  control of composition (binder content and aggregate grading) shows only normal variations and no difference between WMA and HMA.
Production control

- Control of moisture content in ready mixture
- The moisture content has been tested continuously on mix samples from the WMA as well as the HMA production
- The set up requirement of < 0.15% have been met on all samples, with one or two exceptions at 0.16%
- The moisture content of the HMA is normally below 0.05%, so there is a small disparity between the production techniques
- No distinction between the various mixes regardless of differences in RAP content (between 5 and 30 %)
Control of pavement homogeneity by Linear scanning

- The linear scanner (not be confused with an ordinary video camera) is used to control the tendency of separation/segregation of the mix/pavement by measuring the variation of the surface temperature
Linear scanner – Not so good picture
Control of pavement homogeneity by Linear scanning

- To evaluate the results so called “Risk areas” are defined. They stand for areas where the temperature is lower than 10% of the measured average. A Risk factor (expressed in area) of less than 2.5% is considered as very good.
Linear scanner – Good picture
Linear scanner
Control of pavement homogeneity by Linear scanning

- With the WMA the values are extremely good with figures very close to zero with an average for all areas of 0.19%
### Void content %
Cores from pavement

<table>
<thead>
<tr>
<th></th>
<th>HMA</th>
<th>WMA</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of samples</td>
<td>Avg and std</td>
<td>No of samples</td>
</tr>
<tr>
<td>Wearing course</td>
<td>10</td>
<td>2,4±0,7</td>
<td>43</td>
</tr>
<tr>
<td>Binder course</td>
<td>5</td>
<td>3,9±1,5</td>
<td>45</td>
</tr>
<tr>
<td>Base course 32</td>
<td>7</td>
<td>4,0±1,2</td>
<td>40</td>
</tr>
<tr>
<td>Base course 22</td>
<td>5</td>
<td>4,4±0,9</td>
<td>33</td>
</tr>
</tbody>
</table>
## Water sensitivity ITSR %
Cores from pavement

<table>
<thead>
<tr>
<th></th>
<th>HMA</th>
<th>WMA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of samples</td>
<td>Avg and std</td>
<td>No of samples</td>
</tr>
<tr>
<td>Wearing course</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Binder course</td>
<td>1</td>
<td>75</td>
<td>2</td>
</tr>
<tr>
<td>Base course 32</td>
<td>2</td>
<td>77±1,2</td>
<td>5</td>
</tr>
<tr>
<td>Base course 22</td>
<td>1</td>
<td>77</td>
<td>2</td>
</tr>
</tbody>
</table>
## Change in softening point °C - from tank to pavement

<table>
<thead>
<tr>
<th></th>
<th>HMA</th>
<th>WMA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of samples</td>
<td>Avg and std</td>
</tr>
<tr>
<td><strong>Wearing course</strong></td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Binder course</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Base course 32</strong></td>
<td>1</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Base course 22</strong></td>
<td>1</td>
<td>9.2</td>
</tr>
</tbody>
</table>
Change in softening point from tank to pavement

- The RAP (R&B about 60 °C (140 °F) content counts for an increase of about 6.6 °C (11.9 °F) in the AC32 base (30% RAP) and for about 2.8 °C (3.6 °F) in the AC16 bin (20% RAP).

- This means that the increase due to the production is limited to about 2-3 °C (3.6-5.4 °F), and it is the same for both WMA and HMA.

- The difference is normally some degrees higher in batch-plants.
## Resistance to abrasion and deformation

Cores from pavement

<table>
<thead>
<tr>
<th></th>
<th>HMA</th>
<th>WMA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of samples</td>
<td>Avg and std</td>
</tr>
<tr>
<td>Resistance to abrasion cm³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wearing course</td>
<td>4</td>
<td>32±3</td>
</tr>
<tr>
<td>Resistance to deformation Micro strain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Binder course</td>
<td>1</td>
<td>12 600</td>
</tr>
</tbody>
</table>
Conclusions

- The short conclusion is that we have really produced a WMA similar to a Hot-mix asphalt.
Are there any risks?

- One main risk parameter for WMA!
- The most important factor seems to be the water sensitivity, as there is a tendency in the results that the ITSR are somewhat lower than for the HMA, even if they are inside tolerance limits.

- Why?
- Because a little more moisture and a little higher void content
RAP is important for the process, but keep it dry.
Opening day 5th of October 2011

THANKS FOR YOUR ATTENTION!