France’s Perspective on Warm Mix: Research and Practice

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Definition of Warm Asphalt Mixes

- Any practical/technical mean
- To allow reduction of manufacturing and/or laying temperature
- While keeping the same performances as Hot Mix Asphalt
- With final performances achieved just after laying and cooling

Terminology

Current practice of Warm asphalt in France

Development of WAM in France

- First studies and researches: 2000-2003
- Experimentation: 2002-2005
- Industrialization: since 2004-2006
- Applications in various conditions
  - Any type of network, traffic, climate
  - Any type of material (surface or base course)
  - New construction and maintenance

Types of processes used in France

- Use of binder additives to modify binder/aggregate interface and ensure coating at low temperature
- Use of bitumen foaming (pressure or not)
  - By keeping residual water in the aggregates
  - By using water in aqueous phase, ...
- Use of sequential coating steps
Available products in France (2011)

<table>
<thead>
<tr>
<th>Technique</th>
<th>Name</th>
<th>Manufacturing temperature range (ºC)</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder Additive</td>
<td>ETIMA</td>
<td>30 to 45</td>
<td>MALET</td>
</tr>
<tr>
<td></td>
<td>EVOTHERM MA3</td>
<td>30 to 45</td>
<td>EUROVIA</td>
</tr>
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<td></td>
<td>EB 130ºC</td>
<td>30 to 45</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td>Foaming process</td>
<td>EVOTHERM DAT5</td>
<td>40 to 60</td>
<td>EUROVIA</td>
</tr>
<tr>
<td></td>
<td>EBT 130ºC</td>
<td>30 to 45</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td>Foaming process and sequential coating</td>
<td>EBT 90ºC</td>
<td>50 to 80</td>
<td>WAM-FOAM</td>
</tr>
<tr>
<td></td>
<td>ETK IV</td>
<td>50 to 80</td>
<td>3E - DB</td>
</tr>
<tr>
<td></td>
<td>EBT 130ºC</td>
<td>50 to 80</td>
<td>Up to 60</td>
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<tr>
<td></td>
<td>EFM-FCM</td>
<td>50 to 80</td>
<td>EIFFAGE Travaux Publics</td>
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<td></td>
<td>IB - CB</td>
<td>50 to 80</td>
<td>OPERATING licence (owner SHEMEL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 to 80</td>
<td>COLAS Group</td>
</tr>
</tbody>
</table>

In addition: Increase of foaming processes (from US – Atek, Gencor, Maxem,...)
Development of specific binder by French bitumen company (Total)

Consequences for asphalt plants

• No modification for specific binders or additives in bitumen
• Necessary modifications (more or less important) for
  • Foaming
  • Double coating
  • Sometimes necessary reduction of production rate

Examples of quantitative evolution

Approximately near HALF million ton applied in 2008,
2010 : ONE million ton in France among 40 millions tons/year of HMA

First assessment of French survey of WAM

• In laboratory
  • Mechanical performances are similar as HMA
  • But stripping resistance (Duriez test) is slightly lower than HMA
• Manufacturing in plant
  • Production temperature from 90ºC to 130ºC
  • Residual moisture control seems difficult (for ‘water’ processes)
• Implementation and laying
  • Laying and compaction temperature from 70ºC to 120ºC
  • High compaction energy is required especially for base course
  • Workability at middle term must be monitored
• Environmental field
  • Reduction of emissions
  • Reduction of energy consumption

Research needs

• Assess global energy consumption vs. traditional HMA
• Assess fume emissions reduction (effect of additives/binder)
• Assess coating quality in lab
• Assess durability under traffic
• Assess aging properties
• Assess usability of performance-based specifications (representativeness of laboratory manufacturing process vs. plant process)
LCPC Research project ‘OPTIMIRR’ 2006 -2012

Optimization of Pavement Materials and Reclaimed Asphalt Pavement Incorporated into Roads

- WAM = Environmentally friendly processes?
  - Aggregates (partly or fully) heated
  - Bitumen temperature still high
  - Complexity of Mixing processes
  - Additives (paraffin, zeolites, …), recyclibility?
- Foaming bitumen with steamed water: ‘stripping effect’ = ecologic benefit?
- Residual water content in warm mix: aggregate/bitumen interface durability, long term behaviour under heavy traffic?

Lot’s of questions waiting for answers >> Researches in progress

Asphalt fumes

- Asphalt manufacturing (and implementation)
- Fumes
- Organic aerosols
- Inorganic particles
- Volatile and semi-volatile organic compounds: VOC and SVOC

Compounds emitted in our laboratory conditions TOC(e)

Analytical systems to measure asphalt emissions

- Evaluation and separation of TOC by a Flame Ionization Detector (FID)
- Evolution of Total Organic Compounds TOC(e) emissions according to time at a stirring velocity of 20 rpm

One studied indicator = Emission Potential

The emission Potential (EP) is calculated by integrating the area under TOC(E) curve according to time

Temperature and mix design influence

- Increase of Temperature = Increase of TOC(e) emission

Bitumen aging and fumes emissions

Correlation between Emission Potential and bitumen aging
**Durability and performances of WMA**

- Survey of existing job sites
  - French expert task group on ‘WMA processes’ of SETRA (road directorate)
- Accelerated Pavement testing to assess durability under traffic
- Enabling to check performance based specification applicability for WMA

**Conclusions**

- WMA durable trend in France
  - Increasing use with promising results
- Still research needs
  - Need of a global environmental assessment tool (like for other techniques)
  - Existing experiments on site for fume assessment to correlate to laboratory
- Need for job sites surveys
  - To assess durability under traffic
  - To check and/or improve performance based specifications for these mixes

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**Thank you for your attention!**

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