France’s Perspective on Warm Mix: Research and Practice

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IFSTTAR - France
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

Cold asphalt

Half-warm asphalt

Warm asphalt

Hot mix asphalt

HEATING

VAPORIZATION

DRYING

L Fuel / Ton

0 20 40 60 80 100 120 140 160 180 (°C)
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 reduction (°C)</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binder Additive</strong></td>
<td>ETI MA</td>
<td>30 to 45</td>
<td>MALET</td>
</tr>
<tr>
<td></td>
<td>3E - LT</td>
<td>30 to 45</td>
<td>COLAS Group</td>
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<tr>
<td></td>
<td>EVOTHERM MA3</td>
<td>30 to 45</td>
<td>EUROVIA</td>
</tr>
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<td></td>
<td>EBT 130°C</td>
<td>30 to 45</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td><strong>Foaming process</strong></td>
<td>EVOTHERM DAT5</td>
<td>40 to 60</td>
<td>EUROVIA</td>
</tr>
<tr>
<td></td>
<td>EBT 130°C</td>
<td>30 to 45</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td><strong>Foaming process and sequential coating</strong></td>
<td>EBT 90°C</td>
<td>50 to 80</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td></td>
<td>EBE</td>
<td>50 to 80</td>
<td>Operating licence (owner LEA-CO)</td>
</tr>
<tr>
<td></td>
<td>EBT 130°C</td>
<td>30 to 45</td>
<td>EIFFAGE Travaux Publics</td>
</tr>
<tr>
<td></td>
<td>WAM-FOAM</td>
<td>Up to 60</td>
<td>Operating licence (owner SHELL)</td>
</tr>
<tr>
<td></td>
<td>3E - DB</td>
<td>40 to 45</td>
<td>COLAS Group</td>
</tr>
</tbody>
</table>

In addition: Increase of foaming processes (from US – Astek, Gencor, Maxam …)
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 90°C to 130°C
  - Residual moisture control seems difficult (for ‘water’ processes)

- Implementation and laying
  - Laying and compaction temperature from 70°C to 120°C
  - 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
Current research activities on WAM
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

Particles

Gas

Inorganic particles

Organic aérosols

Volatile and semi-volatile organic compounds: VOC and SVOC

Compounds emitted in our laboratory conditions

TOC(e)
LCPC Asphalt fumes generator

**Objective**

Environmental Assessment and ranking of **bituminous mixes** in lab
Efficient laboratory tool to study and **forecast** asphalt fumes

**Functions**
- Generate fumes
- Collect / Sample
- Analyse

**Parameters studied**
- Mix design
- Binder
- Process
- Manufacturing temperature
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

Ref Gaudefroy ISAP 2008 paper 110

Binder content: 5.1% WMA, 3.75% HMA

Temperature and mix design influence

EP * 10^3 (mg/m^3/kg of bitumen.s)
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
Thank you for your attention!

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