RAP for a sustainable development

Australian Asphalt Pavement Association Study Tour to Europe
Arche de la Défense
4th May 2012
Paul MARSAC
## Overview: figures (2010 EAPA)

<table>
<thead>
<tr>
<th></th>
<th>RA available</th>
<th>recycled in HWMA</th>
<th>RA available</th>
<th>recycled in HWMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>50 Mt</td>
<td>24 Mt</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>7 Mt</td>
<td>3 Mt</td>
<td>40%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>HWMA production</th>
<th>avail. RA / HWMA prod.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>300 Mt</td>
<td>17%</td>
</tr>
<tr>
<td>France</td>
<td>40 Mt</td>
<td>18%</td>
</tr>
</tbody>
</table>

(average recycling rate for 100% RA recycling)
Overview: different practices in EU

Different local trade-offs between:

- RA availability
- Supply of aggregate
- Environmental legislation
- Incentive policies
- Landfill dumping fees
- Hauling costs
- Plants fit for recycling
Overview: RA recycling trends

% of available RA recycled

Year

2006 2007 2008 2009 2010

Germany
Netherlands
France
Italy

(EAPA)
Mixing plant fittings

France ≈ 500 mixing plants (< 180 fit for hot recycling)

Batch plant ≈ 50%

Continuous plant ≈ 50%

Max RA content < 30%

Limitation: RA water content
Mixing plant fittings

Some plants fit for high RA content

Parallel drum
Max. RA content ≈ 60%
RA : product specifications \((EN 13108-8)\)

Delivery ticket and product sheet shall contain:

- Identification
  supplier, designation (U RA d/D), date time of delivery
- Presence of foreign matter
  \(F_1 \Rightarrow\) cement concrete, bricks, metal \(\leq 1\%\)
  synthetic materials, wood, plastics \(\leq 0.1\%\)
- Max. size of the RA particles (U)
- Binder content
- Binder type and properties
  paving grade, modified, hard grade, with additive
  mean Softening point (R&B) or Penetration (Viscosity at 60°C for soft asphalt)
- Aggregate grading, d and D(max)
- Feedstock quantity
RA : product specifications *(EN 13108-8)*

If required :

- **Source**
  - Mix type (EB..)
- **Type and properties of aggregate**
- **Homogeneity of the feedstock**
# Recycling rate / RA properties

## Recommended use of RA in HMA

<table>
<thead>
<tr>
<th>Pavement structure</th>
<th>Wearing course</th>
<th>0%</th>
<th>10%</th>
<th>30%</th>
<th>10%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder course</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base course</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RA components properties</th>
<th>Binder</th>
<th>Span of the binder content</th>
<th>&gt;2% or NS</th>
<th>≤2%</th>
<th>≤1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;B or Pen</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>aggregate</th>
<th>Grading curve</th>
<th>NS</th>
<th>D span ≤10% 2mm span ≤15% 0,063 mm span ≤4%</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>properties</th>
<th>NS</th>
<th>LA≤20 MDE≤15 PSV≥50</th>
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</table>

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*Recycling rate depends on RA homogeneity*
Assessment of the resulting binder

Combination laws
only for pure bitumen, not too very different

$$\log \text{pen}_m = \frac{b_o}{100} \log \text{pen}_o + \frac{b_n}{100} \log \text{pen}_n$$

$$TBA_m = \frac{b_o}{100} TBA_o + \frac{b_n}{100} TBA_n$$

$$\log(\log G_m^*) = \frac{b_o}{100} \log(\log G_o^*) + \frac{b_n}{100} \log(\log G_n^*)$$

$$b_o + b_n = 100$$

NF EN 13108-1
Annex A
Preliminary study in lab

- Assess the sources: homogeneity of RA
- Identification of components (on different road sections and pavement layers): binder content and residual properties, granularity of milling, EN 13108-8 requirements
- Formula of new mix with RA (rate of recycling, nature of bitumen or rejuvenator added, aggregates properties)
- Performances must be equal to those of new AC
- Traditional pavement design method

Policy to promote recycling:

in France no new study needed if the rate of recycling is

< 10% in wearing course
< 15 % in binder, base, sub base courses
Mastering of the recycling techniques

- **Low rate**
  - Common
  - 25%
  - 50%

- **High rate**
  - Mastered processes
  - 50%

- **Very high rate**
  - Special techniques
  - 70%

- **Recycling rate**
  - RA availability problems

- Special sites
- Thorough study
- ≠ RA fractions (sieving)
- Need for feedback
- Special mixing plant
Research example: compatibility new-old binder

(*) PhD work of Laëtitia El Bèze

- Assess degree of heterogeneity RAP bitumen and new binder

- Ageing and mixing simulation in laboratory

- Observation of the distribution of chosen tracers within recycled asphalts by microscopic techniques
Research example: compatibility new-old binder

(*) PhD work of Laëtita El Bèze

- Follow up of the spatial repartition of sulfates by X-rays Fluorescence microscopy and XANES microscopy in a synchrotron

- Proposed model: mobilization of the aged bitumen layer leading to partial homogeneity between aged and new binder

- To be confirmed on more realistic RAP
Assessment after 30 years of experience in RAP

- Recycling rate RA in new HMA: 10 to 70%
  - Current average near 20 to 25%
- Global behavior: without major problem, even with PmB excepted on specific sites:
  - Degradations with cracks, fatigue, but also rutting sometimes observed
  - Due to hazardous parameters from RAP (hardening binder, heterogeneity,...) or higher rate recycling
- Maintenance study and mix design very important
- Difficulties to take into account the wear of old aggregates on the surface friction properties
Tendencies et evolutions

• WMA techniques (but <2 or 3% of total HWMA production)
• Recycling essential to respect the topics of sustainable development
• European know-how sharing:
  – Harmonization of practices in Europe (Direct Mat project – RILEM SIB TG5)
  – Recommendation guide: state of the art, practical advises, specifications, prescriptions,…
• Researches:
  – Accelerated ageing, to predict and anticipate the behaviors on field
  – Recycling with high rate, reach near 100%
  – Performances of binder after recycling: compatibility, homogeneity of mix, influent factors governing binders mixing, healing
  – Definition of damage criteria on old AC, to assess the “level of recyclability”
  – Fast RA characterization
  – Inventory and monitoring of existing sites, long term performances survey
Conclusion

• The in plant recycling of RA in HMA is a competitive solution in term of:
  – Environment
  – Technique
  – Economy
  – Energy
  – Sustainable development

• But researches still needed:
  – to improve the whole performances of material, essentially for the prediction of ageing and medium and long time performances
  – to assess the criteria regarding Sustainable Development (LCA)