Eco-designed pavements
Green chemistry & smart testings

Simon Pouget

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Key figures of French asphalt industry in 2016

- Asphalt mixture production: 33.1 millions tons
- Bitumen: 2.4 millions tons
- Bituminous binder production: 1 million tons
- Average recycling rate: 20%
French policy

- Voluntary Engagement Agreement (signed in 2009)
  - Recycling rate of 15% in 2017
  - 33% decrease of emissions in 2020/2009
  - Warm mix production: 30%

- Energy transition law
  Recycling of 70% of waste from construction (2020)
  Circular economy

Sweden Carbon neutral in 2045?
« Grey debt »

Graph showing the state of a roadway over its age, with categories from Excellent to Ruined.
How pavement industry can contribute?
Green Chemistry

Recycling

Bio-based binder produced from renewable and local resources

Reclaimed asphalt
BioRePavation

- Infravation call
- Europe & US fundings

- Bio-Recycling
  - 3 tested solutions
  - Recycling rate up to 70%

Sylvaroad™
Biophalt®
Epoxidized methyl soyate
LCA on binder

Standard EN 15804
Biogenic carbon

<table>
<thead>
<tr>
<th>Binder</th>
<th>Global warming potential [t CO2 eq]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>0.247</td>
</tr>
<tr>
<td>Biophalt</td>
<td>-1.52</td>
</tr>
</tbody>
</table>

Eco-designed pavement

SEVE calculation for 1 000 tons of mixture
- Conventional mixture with 20% of reclaimed asphalt + bitumen
- Biophalt mixture with 60% of reclaimed asphalt

<table>
<thead>
<tr>
<th>Materials extraction</th>
<th>Transport</th>
<th>Mixture production</th>
<th>Paving operation</th>
<th>Total</th>
<th>Comparison / ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional mix</td>
<td>Route/VRD</td>
<td>12,0</td>
<td>7,2</td>
<td>16,7</td>
<td>1,5</td>
</tr>
<tr>
<td>Biophalt mix</td>
<td>Route/VRD</td>
<td>-36,7</td>
<td>3,8</td>
<td>16,3</td>
<td>1,5</td>
</tr>
</tbody>
</table>
Smart testing
Modal analysis to characterise the complex modulus of asphalt concrete
Swedish/French collaboration
Background

- **Resonance frequencies**
  - The resonance frequencies of a solid with free boundary conditions depend on:
    - Stiffness \((E)\)
    - Density \((\rho)\)
    - Dimensions \((l, A)\)

\[ f \propto \frac{1}{l^2} \sqrt{\frac{AE}{\rho}} \]
Principle
Merci de votre attention
Tack för din uppmärksamhet

simon.pouget@eiffage.com