Sustainability of bituminous mixes manufactured at lower temperatures.

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Outline

- The use of LCA in the evaluation of bituminous mixes.
- Comparison of hot and low temperature mixes.
- Key parameters to improve sustainability of pavements.
LIFE CYCLE ASSESSMENT

How has been implemented LCA in Proyecto Fénix?

- Ecoindicator 99
- Egalitarian version
- Types of damages evaluated:
  - Ecosystem quality.
  - Resources
  - Human health
GLOBAL LCA EVALUATION OF A PAVEMENT

“from the cradle to the grave”

Impacts of traffic operation are 10-100 times those induced by construction and maintenance (30 years period)

LCA EVALUATION OF ASPHALT CONCRETE

ECOSYSTEM QUALITY

- TRANSPORT: 19.84%
- MIX PRODUCTION: 1.61%
- LAYING: 4.81%
- RAW MATERIALS AND FUELS: 73.74%

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LCA EVALUATION OF ASPHALT CONCRETE

RESOURCES

- MIX PRODUCTION: 0.01%
- TRANSPORT: 4.47%
- LAYING: 3.26%
- RAW MATERIALS AND FUELS: 92.26%
LCA EVALUATION OF ASPHALT CONCRETE

HUMAN HEALTH

- RAW MATERIALS AND FUELS: 74.48%
- TRANSPORT: 15.17%
- MIX PRODUCTION: 5.53%
- LAYING: 4.81%
LCA EVALUATION OF ASPHALT CONCRETE

DAMAGES DISTRIBUTION (ECOPOINTS)

- Raw materials and fuels: 87.67%
- Mix production: 1.49%
- Transport: 7.22%
- Laying: 3.61%

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LCA EVALUATION OF ASPHALT CONCRETE

CLIMATE CHANGE

- MIX PRODUCTION: 29.53%
- TRANSPORT: 11.09%
- LAYING: 3.63%
- RAW MATERIALS AND FUELS: 55.76%
Sustainability of bituminous mixes manufactured at lower temperatures

- Main claims of warm and half-warm mixes:
  - Energy savings
  - Lower GHG emissions
  - Lower COV emissions (health and safety).
ENVIRONMENTAL IMPACTS OF HOT vs WARM MIXES (UP TO MANUFACTURING)

- Cog. plant (Avoided burdens)
- Cog. plant (Electricity)
- Cog. plant (Combustion)
- Trolley
- Thermal oil circuit
- Bitumen tanks
- Mixer
- Filler lift
- Aggregate lift
- Screening
- Drier (Combustion)
- Drier (Extractor)
- Drier (Electricity)
- Conveyor belt
- Loader
- Aditive
- Natural gas in Cogeneration Plant
- Natural gas in drier
- Diesel
- Bitumen transport
- Bitumen modifier
- Bitumen fabrication
- Aggregate transport
- Aggregate extraction
- Thermal oil
KEY PROPERTIES OF ASPHALT PAVEMENTS

DURABILITY

- Stiffness.
- Fatigue resistance.
- High resistance to stripping.
KEY PROPERTIES OF BITUMINOUS MIXES

STIFFNESS (I)

35-50 BITUMEN (PENETRATION 50 X 0,1 MM)

<table>
<thead>
<tr>
<th>Mix temperature</th>
<th>Recovered binder (penetration x0,1 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>155-160°C</td>
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-25% stiffness

• Should we consider the lower stiffness to redesign the pavement?
• Is there any improvement in fatigue?
KEY PROPERTIES OF BITUMINOUS MIXES

![Diagram: Stiffness Modulus vs Compaction Temperature (Hot Mixes)]

- **S-12 60/70 -3 SER**
- **AC16 Surf 50/70 S COL**
- **F-10 BM3a COL**
- **F-8 BM3c SOR**
- **S-20 BM3c SOR**
- **S-20 10%RAP-2 SOR**
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**Conclusions**

- LCA allows a wider vision to get real sustainability.
- Durability of the pavement is the main goal.
- Warm and half-warm mixes are in the right way but must be thoroughly studied according to performance criteria.
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Thank you for your attention!

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