Re-use of Materials in Asphalt Pavements. Interest of Society. Environmental and Sustainability Issues: Benefits and Drawbacks

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Asphalt Recycling and Materials Re-use in Asphalt Pavements
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Social and Environment

• Environmental impact
  – Construction only a small contribution compared to entire infrastructure operation (usage)
  – Part of overall operation under our control

• Emissions & energy consumption
  – Warm and cold (construction & maintenance) processes
  – Pollution absorbing roads (Titanium oxide slurry surfacing)

• Use of finite resources
  – Local recycling (Reduce need for transport)
  – Insitu (Mobile plant)
Key Players

- WRAP (UK)
- AggRegain (UK)
- SAMARIS
- EAPA
- RILEM TC 206 ATB, TG5 Recycling
- FP7 consortia
Future Strategy

- Integrating material flows
- Life cycle assessment (LCA)
- Design for maintenance
- Marketing
Integrating Material Flows

- (Waste management)
- Network level
- Generating asphalt planings
- Linked to recycling needs
Design for Maintenance

• (Automotive industry)

• Aim of recycling built into initial construction

• Currently use recycled material in ‘lower spec’ application

• Keeping good records
Marketing

- (Appliances)
- Energy rating
- ‘Road materials’ with targets (green house gas emissions)
Life Cycle Assessment (LCA)

- LCA is a tool to evaluate the environmental impacts associated with stages of a product’s lifecycle from cradle to grave
- ISO 14040
- Sensitivity analysis
- Quantify environmental impacts
- Target greenhouse gas emissions
- Manufacturing & maintenance versus transport
Phases of LCA

- Goal and scope definition
- Life cycle inventory analysis
- Life cycle impact assessment
- Life cycle interpretation

Direct applications:
- Product-development and improvement
- Strategic planning
- Public policy-making
- Marketing
- Other
Inventory Analysis

Environmental impact assessment of track systems

Manufacturing → Construction → Operation → Dismantling and disposal
Transportation

Recycling

Maintenance → Landfill
Inventory Analysis

**Inputs:**
- Materials: steel, cement, aggregate, grout, etc.
- Travelling distance: materials, plant, workers?
- Fuel consumption: non-combined and combined
- Type of machinery: energy consumption during construction
- Life expectancy of components: replacement and renewal
- Maintenance period: replacement and renewal
- Recycling percentage: during maintenance and demolition

**Outputs:**
- Energy consumption: throughout the life cycle
- Emission to air: from materials, fuel and manufacturing stage
- Emission to water: materials, manufacturing and construction
- Waste and land fill: materials, construction, maintenance and demolition
- Noise pollution: construction and demolition
FP7 – Re-road

• Re-road – End of life strategies of asphalt pavements

• FEHRL proposal

• A level of re-use of 99% for recovered asphalt concrete, to be reintroduced into new mixes with a minimum of downgrading of the material and a minimal introduction of virgin material
Material Re-use

- Crumb rubber tyres
- Industrial slags
- Waste products – glass cullet & plastics
- Bio-materials
Crumb rubber

- Wet process – small quantities & compete with synthetic PMBs
- Dry process – absorption & reduced material performance

![Graph showing absorption rate vs viscosity for Middle East and Venezuelan bitumens.]

\[ y = 1823.8x^{-1.0418} \]

\[ R^2 = 0.6344 \]
Slags & Glass Cullet

Number of Conditioning Cycles vs. Stiffness Modulus Ratio

- Grit MB = 6.2% Vv = 1.0% Mix #8
- Grit MB = 6.0% Vv = 2.5% Mix #9
- Slag BFS Filler MB = 6.0% Vv = 4.1% Mix #10
- Slag Limestone Filler MB = 6.0% Vv = 3.0% Mix #11
- Slag Limestone Filler MB = 5.5% Vv = 2.9% Mix #12

NTEC
Slags & Glass Cullet

Axial Strain (%) vs. Number of Load Cycles

- Limestone Mix #1
- Limestone + Glass Mix #2
- Limestone + Glass Mix #3
- Slag MB = 4% Mix #4
- Slag MB = 5% Mix #6

Mix #1
Mix #2
Mix #3
Mix #4
Mix #6
Glass
Slag

Number of Load Cycles
Asphalt Recycling - RAP

• Growing use to overcome bitumen cost increase and aggregate shortage

• RAP not generally mandatory

• Main techniques involve hot recycling

• RAP contents limited, <50%, usually <30%, <10% surfacings

• Cold cycling – 100%

• Usually in base and binder layers
Final Thoughts

• More holistic approach needs to be taken to material re-use and asphalt recycling

• Experience needs to be shared amongst researchers, practitioners and clients
Thank You