Towards production of 100% recycled asphalt

Martins Zaumanis

Rajib Mallick, Robert Frank
Recycling

- 50 million tons of RAP available in Europe

91% recycled
52% reused
100% recycling – is it possible?

Materials
100% recycling – is it possible?

- Materials
- Technology
100% recycling – is it possible?

- Materials
- Technology
- Mix design
100% recycling – is it possible?

- Materials
- Technology
- Mix design
- Mindset
100% recycling – is it possible?

- Materials
- Technology
- Mix design
- Mindset
100% recycling – is it possible?
100% recycling – is it possible?
Mix design

Bitu-man
Rejuvenator dose optimization

\[
\text{DOSAGE} = \log_e \left( \frac{PEN}{A} \right) / B
\]

Penetration, dmm

0% 6% 12% 18%

Dosage

Brown Grease

Virgin binder

Aromatic extract

Virgin binder

Reduced Grease

Distilled tall oil

Yellow grease

Organic blend

WEO
Rejuvenator dose optimization

- WV Oil
- WV Grease
- Organic Oil
- Distilled Tall Oil
- Aromatic Extract
- WEO
Rejuvenator dose optimization

Dose

0% 5% 10% 15% 20% 25% 30%

WV Oil  WV Grease  Organic Oil  Distilled Tall Oil  Aromatic Extract  WEO

High PG
Rejuvenator dose optimization

![Graph showing the dose optimization for different materials.](image)

Key:
- **High PG**
- **Low PG**

Materials:
- WV Oil
- WV Grease
- Organic Oil
- Distilled Tall Oil
- Aromatic Extract
- WEO

Dose:
- 0%
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
Rejuvenator dose optimization

100% Blending

Dose

0% 10% 15% 20% 25% 30%

WV
Oil
Grease

Organic
Oil

Distilled
Tall Oil

Aromatic
Extract

WEO

Interm. PG
Low PG
Penetration
High PG
9.5mm Superpave mix

Binder content: 5.9%
Rejuvenator: 12%
Air voids: 7%±0.5%
VMA 17.4±0.5%
VFA 59.5±1.8%
Rutting

![Graph showing rut depth vs. wheel passes for various mixtures.]

- Virgin Mix
- WV Grease
- WV Oil
- Organic Oil
- Distilled Tall oil
- WEO
- Aromatic Extr
- RAP Mix

Rut Depth, mm vs. Wheel Passes
Low temperature cracking
Low temperature cracking

Stress, kPa

Temperature, C

-25  -20  -15  -10  -5  0
Thank you!

Martins Zaumanis
http://zaumanis.com
martins.zaumanis@empa.ch