Use of rejuvenators : a pragmatic approach from Belgium

Tine Tanghe
• Belgium: front-runner worldwide for use of RA (reclaimed asphalt)
  – success story petroleum crisis in 70-ties
  – important experience with hot recycling
  – application % very high in base and binder layers (up to 60%)

• However, reuse forbidden in surface courses ↔ allowed in the past (90ties till 2009; forbidden > 2010 with new version of standard); since 2019 reintroduced to max 20% for low volume roads (AC-surf)

• Increasing issues in case of multiple reuse: ‘multi-recycling’ due to ageing of the binder (‘black rock’)

Need the use of rejuvenators to reactivate the aged binder

⇒ Maintain or improve the performance characteristics
Use of rejuvenators

- Needs and questions coming up with their use
- More practical experiences needed => 2 projects ongoing: Re-RACE and Rejuvebit

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<th>REJUVEBIT</th>
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<td>Procedure for screening efficiency of rejuvenator</td>
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<td>Standard Methodology for lab evaluation (e.g. ITT - gap in EN standards)</td>
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<td>Validation study: link lab (ITT) – practice</td>
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<td>Global evaluation on sustainability: Important for Green Public Procurement</td>
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<td>Gain experience in production with the use of rejuvenators and construction on the road (% RA + rejuvenators)</td>
<td>✔️</td>
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<tr>
<td>Start and duration project</td>
<td>1/6/17 – 2 y</td>
<td>1/11/18 – 2 y</td>
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Re-RACE: set up study

- Research project: Re-RACE ‘Rejuvenation of Reclaimed Asphalt in a Circular Economy’

- Collaboration BRRC – Stadsbader Inc and Kraton Chemical (supplier Sylvareoad™ RP1000)

- Study aiming mainly for:
  - Detailed binder and asphalt evaluation
  - Standard procedure ITT with rejuvenator
  - Validation lab with practice - link

- E&E 2020: 2 papers submitted
  - S.Vansteenkiste et all: on test sections
  - T.Tanghe et all: on labstudy – ITT
Re-RACE: test sections

- Test sections 7 to 11 September 2017 on the production site of the contractor
- Six variants:
  - Base layers AC- base 14 (APO-B) – 4.2 % binder:
    - Mix AC –base 14 with 50 % RA
    - Mix AC –base 14 with 70 % RA
    - Mix AC –base 14 with 70 % RA + rejuvenator
  - Toplayers AC- Surf 14 (APT-B) – 5.5 % binder:
    - Mix AC – surf 14 with 30 % RA
    - Mix AC – surf 14 with 50 % RA
    - Mix AC – surf 14 with 50 % RA + rejuvenator
Re-RACE: test program

• Test program ≠ phases :
  • During asphalt production: dosage rejuvenator, T-measurements, time interval ...
  • During compaction: T-measurements in situ, follow up compaction, homogeneity of compaction,...
  • Taking of bulk material: determination compactibility, water sensitivity, stiffness, ...
  • A posteriori:
    • On cores: water sensitivity and rutting
    • Recovery binder: empirical and rheological tests on binder
    • Follow up durability in time

• Link ITT: on raw materials taken at moment of test sections: compactibility, water sensitivity, stiffness, fatigue, rutting on same mix compositions as sections
Re-RACE : Lab - asphalt - ITT

RA

‘Classic’

Rejuvenator

LAB - ITT

NBN EN 13108-20

VALIDATION Asfalt plant / road

SYLVAROAD™RP1000
Re-RACE: Link plant – lab

Procedures adding rejuvenator in practise

On RA on conveyor belt to parallel drum (upstream)

Directly in mixer

In binder

https://youtu.be/346eHEa7zTE

Source: Boesiger et al., EATA June 2017
Re-RACE: Link plant – lab

Way of adding rejuvenator: practice => lab

On RA on conveyor belt to parallel drum
- ‘COLD’
  - Rejuvenator equally dropped over cold and spread RA
  - RA + rejuvenator: Oven 2.5 ± 0.5 h at 130°C
  - Mix sequence: NBN EN 12697-35
    - Aggregates – RA – binder – filler

Directly in mixer
- ‘WARM’
  - Rejuvenator equally dropped on warm RA in mixing bowl at start
  - RA: Oven 2.5 ± 0.5 h at 130°C
  - Mixing sequence: ≠ NBN EN 12697-35
    - RA - Aggregates – binder – filler
Re-RACE: Exposure time

- Variation ‘exposure times’: COMPACTION
  - 15 min after mixing (‘immediately’)
  - 1 hour after mixing (simulating storage + transport to jobsite)

- Storage in oven at compaction temperature
Base layer

Impact rejuvenator on RA - different points of sampling

- RA on stockpile: pen 20x0.1mm and R&B 64°C
- After “black drum”, loss of 1 grade
- With rejuvenator, gain of 1 grade *
- *: dose calculated to obtain 35/50 in final mix

Impact rejuvenator in final mix

- Mix 70% RA no rej very hard
- Mix 70% RA + rej even better reference mix 50% RA
## Re-RACE: Asphalt results

### Gyratory compaction

<table>
<thead>
<tr>
<th>AC-14 base</th>
<th>LAB ITT</th>
<th>bulk material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyrator (60G)</td>
<td>reference + Rejuvenator + Rejuvenator reference + Rejuvenator</td>
<td>reference + Rejuvenator</td>
</tr>
<tr>
<td></td>
<td>method 1 cold method 2 warm</td>
<td>n.a.</td>
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</tbody>
</table>

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<tr>
<th>15 min waiting before compaction</th>
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<tr>
<td>% voids</td>
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</table>

<table>
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<tr>
<th>1 hour waiting in gyratory mould</th>
</tr>
</thead>
<tbody>
<tr>
<td>% voids</td>
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<th>1 hour in tin before compaction</th>
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</thead>
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<tr>
<td>% voids</td>
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</table>

- Warm/cold: no difference
- 15 min (short time) before compaction: best comparison with bulk material
- 1 hour waiting: large effect on void content
Water sensitivity

- With and without rejuvenator: very good results, no significant difference, complying national specifications
- Warm/cold: no difference
Re-RACE: Asphalt results

Rutting

- With and without rejuvenator: results considered equal
- Cores vs Lab: different results due to unfavourable conditions during compaction
• Joined project UAntwerpen (EMIB – coordinator) and BRRC (partner): RejuveBIT: ‘Sustainable asphalt by use of rejuvenators’

• Demonstration project on the use of rejuvenators from 5 test sections in 2019 – 2020

• Aim: With 5 different (types) rejuvenators and asphalt plants (contractors)
  • Gain practical experience

• Field study in 2019 aims to use rejuvenators in wearing courses with high % RA: 3 sections

• Field study in 2020 aims to use rejuvenators in base courses with high % RA: 2 sections
Rejuvebit: Set-up project

Step 1: Selection sections
- Type of mix by SC
- Composition via asphalt plant
- Dosage additive by supplier

Step 2: ITT – Design phase (check mix)
- Presentation Results to SC => OK

Step 3: Test sections
- Follow-up compaction: temperature and density

Step 4: Tests a posteriori
- Binder and asphalt level

Subcommission (SC):
- contractor - supplier rejuvenator – UA – BRRC - customer
- agreements / information sharing – communication

BRRC
• Sampling bulk material
• cores

BRRC & U.A.
• SC not OK with results

U.A.
### Rejuvebit: test sections

<table>
<thead>
<tr>
<th>Location</th>
<th>Test section 1: Retie</th>
<th>Test section 2: Kallo, Port of Antwerp</th>
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<tbody>
<tr>
<td>Collaboration</td>
<td>BRRC, UAntwerpen, AWV (province Antwerp), Besix Infra and Nynas</td>
<td>between BRRC, UAntwerpen, Port of Antwerp, Willemen Infra Inc and Cargill</td>
</tr>
<tr>
<td>Rejuvenator</td>
<td>Nygen 910 (aromatic petroleum oil), added to binder weighing scale</td>
<td>Anova™ 1817 (bio-based oil) – added to RA on conveyor belt</td>
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<tr>
<td>Type of mix</td>
<td>surface layer AC- surf 10</td>
<td>surface layer AC- surf 10</td>
</tr>
</tbody>
</table>
| Variants | • without RA (fresh binder 50/70) = reference  
• with 20 % RA (fresh binder 70/100)  
• with 40 % RA + rejuvenator (fresh binder 70/100) | • without RA = reference  
• with 40 % RA  
• with 40 % RA + rejuvenator  
• Fresh binder all variants: 50/70 |
| Objective | obtain same empirical properties of the binder ( = pen) | to demonstrate effect of RA in combination with rejuvenator |
Rejuvebit: test sections

Test sections coordinated by BRRC
Continuation project Re-RACE II: ‘Rejuvenation of Reclaimed Asphalt in a Circular Economy’:

- Impact of rejuvenators on aged binders
  - Rheological indicators
  - Thermal analysis (DSC)
  - Screening methodology for rejuvenator efficiency

- Durable re-use of RA in surface layers – impact rejuvenators
  - Control of variability of RA properties
  - Adequate test for workability of asphalt mixtures

- Objective assessment of sustainability (use of RA in combination with rejuvenators)
Thank you

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