Use of rejuvenators in asphalt mixtures

10-11 September 2019 Padova (Italy)

RILEM TC-264 RAP Asphalt Pavement Recycling - Update on Rejuvenators

Dr. Martin Hugener
RILEM - International Union of Laboratories and Experts in Construction Materials, Systems and Structures

The Mission
• The mission of the association is to advance scientific knowledge related to construction materials, systems and structures and to encourage transfer and application of this knowledge world-wide.

The Goals
• to promote sustainable and safe construction, and improved performance and cost benefit for society,
• to stimulate new directions of research and its applications, promoting excellence in construction,
• to favour and promote cooperation at international scale by general access to advanced knowledge.
The RILEM Topics

- Cluster A. Material Processing and Characterization
- Cluster B. Transport and Deterioration Mechanisms
- Cluster C. Structural Performance and Design
- Cluster D. Service Life and Environmental Impact Assessment
- Cluster E. Masonry, Timber and Cultural Heritage

**Cluster F. Bituminous Materials and Polymers (Convenor M. Wistuba)**

Technical Committees:

- 264-RAP: Asphalt Pavement Recycling
- 272-PIM: Phase and Interphase behaviour of bituminous Materials
- 278-CHA: Crack-Healing of Asphalt Pavement Materials
- 279-WMR: Valorisation of Waste and Secondary Materials for Roads
- 280-CBE: Multiphase characterisation of cold bitumen emulsion materials
Working Groups

- **TG 1**: Cold Recycling (Daniel Perraton and Alan Carter, ÉTS Montreal Canada)
- **TG 2**: Non-Cold (Warm and Hot) Recycling (Paul Marsac, IFSTTAR France and Mayca Rubio, University of Granada, Spain)
- **TG 3**: Asphalt Binders and Additives for RA (Martin Hugener, Empa Switzerland and Augusto Cannone Falchetto, University of Braunschweig Germany)
- **TG 4**: Life Cycle Assessment for Optimal RA Usage (T. Parry, University of Nottingham, UK and Y. Qiao, University of New Hampshire, USA)
- **TG 5**: Degree of Binder Activation (Davide Lo Presti, University of Palermo Italy and Kamilla Vasconcelos, University of São Paulo Brazil)
The final outcome of this TG will be to evaluate and standardize tools to properly validate a rejuvenator for the use in asphalt pavements

- Defining methods and parameters apart from rheological values to better characterize rejuvenators (Quality control)
- Methods to characterize aging of rejuvenators and bitumen rejuvenator mixes. Compare different aging methods (RTFOT, …)
- Testing the compatibility between RAP binder and rejuvenator
- The topic of repeated recycling, which is especially interesting but complex for modified binders.
Rejuvenators - Open questions

• What is a «good» rejuvenator? How to assess the properties of a rejuvenator?
• How does the rejuvenator effect the binder and mix properties on short and long term?
• Best formula for calculation of the required rejuvenator amount? Is it the same for all types of rejuvenators? What is the reference method for this (Pen, Ring and Ball, DSR, stiffness modulus of mix, fatigue, ....)?
• What is the reference for rejuvenation? A standard non-modified bitumen, a (polymer) modified bitumen or ? ...
• Quality control: How to verify, we get always the same rejuvenator quality? How to determine the type and amount of a rejuvenator in an asphalt mix.
• How to produce larger amounts of aged binder? Can we use a hard bitumen 10/20 instead of an aged RAP-binder?
Aging of rejuvenator – bitumen blends

- Bitumen and rejuvenator can be of totally different chemistry (bio-based rejuvenator) ⇒ aging mechanism will be different (double bonds of vegetable oils)
- Bitumen aged + Rejuvenator aged = (Bitumen/Rejuvenator mix) aged?
- How will the aging of the rejuvenator effect the bitumen?
- Aging simulation tests have been developed for bitumen. Will they work for bitumen-rejuvenator mixes as well? Will it be similar to the field?
Modified working plan

• A pure Round Robin Test, where everybody tests the same material with the same test methods doesn’t make sense, as this is not (yet) about a validation of a test method or a protocol.

• Still, the limitation of the used materials for, I call it “core experiments”, could make sense. So, what is proposed is more some kind of joint-laboratory test program with the same target, but some variations of materials and methods. In that way a maximum of information with our limited resources is possible.

• In the beginning we will consider binders only, in a later stage, hot mixes are an option.
Modified working plan

1. Rejuvenator
2. RAP-Binder
3. Virgine Binder

- Rejuvenated Binder
- Short term aging
- STA Rejuvenated Binder
- Long term aging
- LTA Rejuvenated Binder
Stage 1: Core experiment

- Blend with same materials but *varying concentrations* to simulate recycling with 60% - 80% - 100% RAP
- Different set of testing methods due to limited amount of reference RAP binder: Complex modulus by DSR, softening point ring and ball done by all labs; penetration, BBR, FTIR testing by selected labs
Stage 2: additional experiment with lab RAP binder

- Principle: Change one material at the time for better comparison

Stage 3: additional experiments with lab RAP binder and other variation (rejuvenator or virgin binder)
Challenges

20 Laboratories from different continents committed to participate
(14 universities, 4 private companies, 2 road authorities)

- No budget: shipping and preparatory work
- Time and workforce: Rilem has often low priority
- Unified testing procedures (EN, ASTM, …) → testing protocol
- Equipment and testing experience
- Skype meetings with very different time zones America – Europe – Asia
First results of Stage 1 (Core experiments)
First results of Stage 1 (Core experiments)
First results of Stage 1 (Core experiments)
First results of Stage 1 (Core experiments)

**Softening point ring and ball - Mean values**

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**Penetration - Mean values**

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Conclusions

- Penetration of the blend was equal to the virgin bitumen but the softening point ring and ball of the blend was lower → some properties show a difference
- There is no significant difference between the blends with 60%, 80% or 100% of RAP binder
- The rejuvenator bitumen blend showed a similar aging behaviour like the virgin bitumen
- In some cases large scattering of the results was observed → a deeper analysis of the results is needed
Future activities

• Analysis and publication of the results at conferences and in papers
  – RILEM STAR report, literature overview on rejuvenator aging
  – Conferences: E&E2020 Madrid, Marepaiv 2020 Zurich, RILEM 2020 Lyon

• Planning of future work:
  – Bitumen aging with other rejuvenators (stage 3)
  – Aging impact on mastic and asphalt mixture
  – Comparison of different test methods for rejuvenator characterization
Thank you all!

Laurent Porot¹, Martin Hugener², Augusto Cannone Falchetto³, Di Wang³, Atsushi Kawakami⁴, Bernhard Hofko⁵, Andrea Grilli⁶, Emiliano Pasquini⁷, Marco Pasetto⁷, Hassan Tabatabaee⁸, Huachun Zhai⁹, Margarida Sá da Costa¹⁰, Patricia Kara De Maeijer¹¹, Wim Van den bergh¹¹, Edoardo Bocci¹², Fabrizio Cardone¹², Alan Carter¹³, Kamilla Vasconcelos¹⁴, Xavier Carbonneau¹⁵, Goran Mladenovic¹⁶, Marko Orešković¹⁶, Tomas Koudelka¹⁷, Runhua Zhang¹⁸, Eshan Dave¹⁸, Aurelie Lorserie¹⁵, Hilde Soenen¹⁹

¹Kraton Chemical, The Netherlands, ²Empa - Materials Science and Technology, Switzerland, ³Technische Universität Braunschweig, Germany, ⁴Public Works Research Institute, Japan, ⁵TU Vienna, Institute of Transportation, Austria, ⁶University of the Republic of San Marino, San Marino, ⁷University of Padova, Italy, ⁸Cargill Industrial Specialties, ⁹Idaho Asphalt Supply Inc., US, ¹⁰National Laboratory of Civil Engineering (LNEC), Portugal, ¹¹University of Antwerp, Belgium, ¹²Polytechnic University of Marche, ¹³LCMB Montreal, Canada, ¹⁴Laboratory of Pavement Technology - University of São Paulo, Brazil, ¹⁵CST COLAS, France, ¹⁶University of Belgrade, Faculty of Civil Engineering, Serbia, ¹⁷Brno University of Technology, Czech Republic, ¹⁸University of New Hampshire, US, ¹⁹NYNAS, Belgium
Thank you

Contact:
martin.hugener@empa.ch

For general information on RILEM TC RAP:
Gabriele Tebaldi gtebaldi@unipr.it