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# INVESTIGATING ASPHALT REJUVENATION – THE USE OF RECLAIMED ASPHALT AND REJUVENATORS IN FIELD TRIALS

2nd International Workshop on Asphalt Recycling Technologies

Dr.-Ing. Nina Nytus

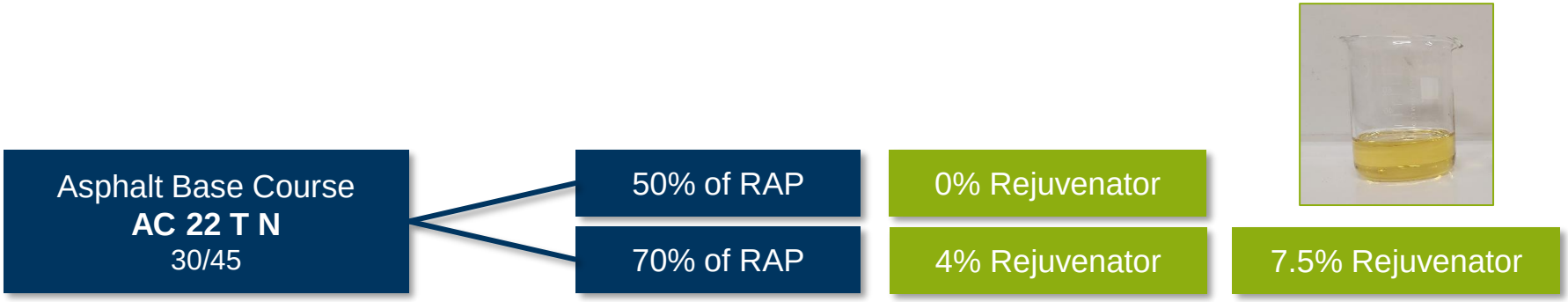
# Motivation

New challenges in the reuse of reclaimed asphalt:

- More complex binder concepts due to modifications, increasing hardness of the binder in the RAP due to decades of (multiple) reuse and the use of rejuvenators

- “Maintenance before construction" but also the conservation of rock and binder resources and the possibility of reducing greenhouse gas emissions make it necessary to incorporate higher-quality asphalt granules into the asphalt pavement as well

# Field Trial 1 – Asphalt Concepts




- Rejuventor is a crude tall oil derived from a renewable resource comprising pine and other wood

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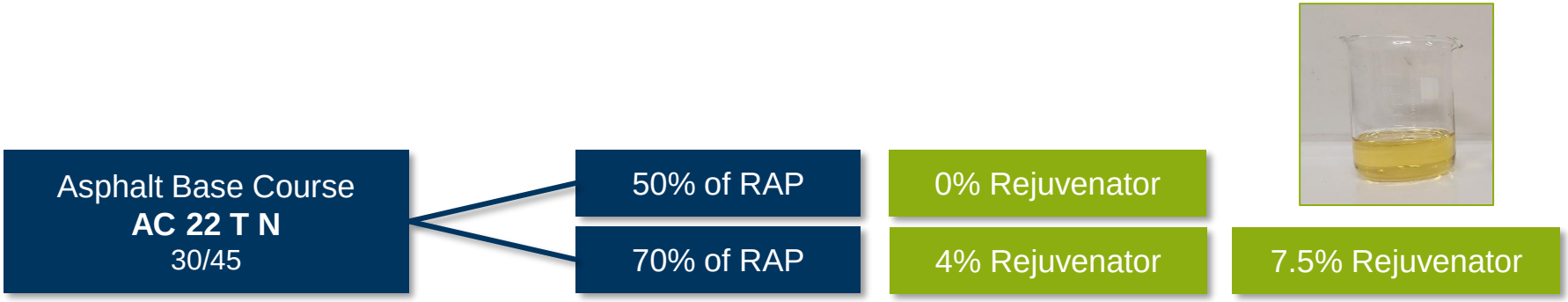
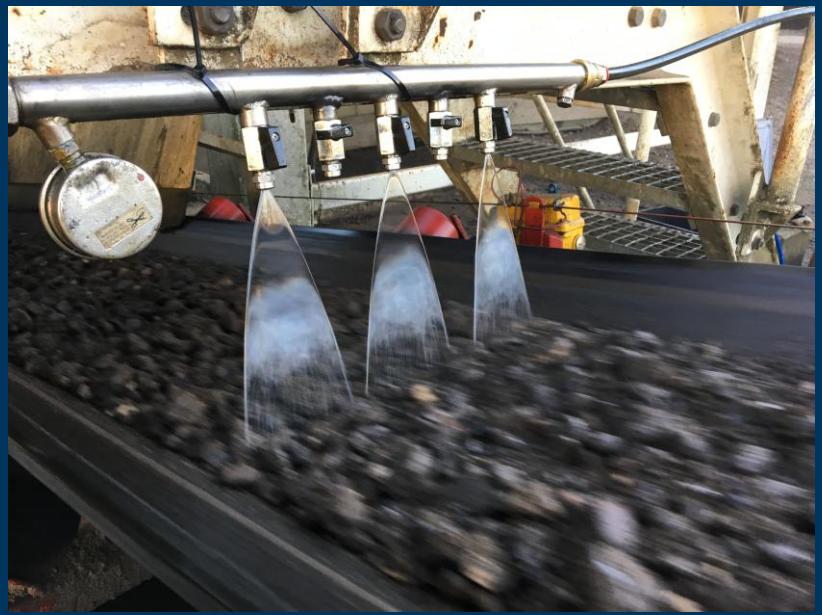


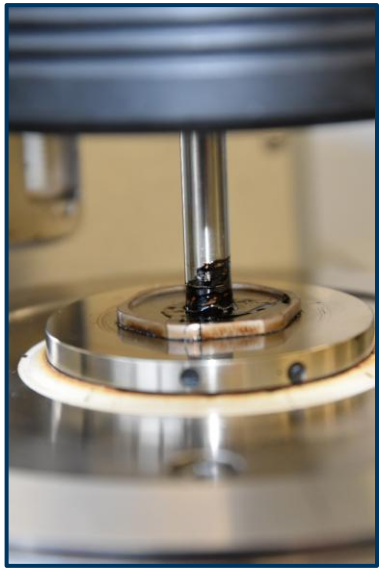

- Rejuventor is a crude tall oil derived from a renewable resource comprising pine and other wood
- RAP Properties: 3.4% bitumen content, softening point ring and ball 71.4 °C
- Addition by spraying onto the asphalt granulate at the reclaimed asphalt conveyor belt

# Field Trial 1 – Asphalt Concepts



# Field Trials

## Field Trial 1 - Test methods



**Complex Shear Modulus and Phase Angle**
**-20 °C to 150 °C**

**Dynamic Stiffness**
**at -10 °C, 0 °C, 10 °C, 20 °C**

# Field Trials

## Field Trial 2 - Asphalt concepts

Asphalt Surface Course
**AC 11 D S**
PmB 25/55-55 A

- 20% of RAP
- 40% of RAP
- 60% of RAP

Asphalt Binder Course
**SMA 16 B S**
PmB 25/55-55 A

- 30% of RAP
- 45% of RAP
- 60% of RAP

- R1 Biobased rejuvenator
- R2 Crude oil based

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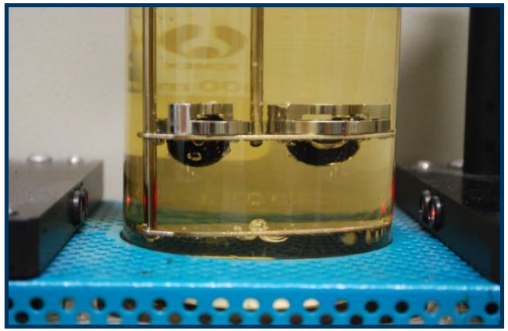
# Field Trials

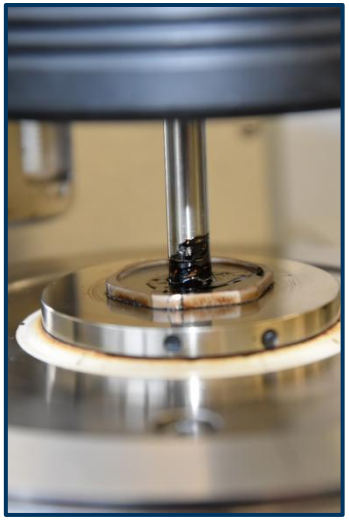
## Field Trial 2 - Test methods

Needle Penetration



Softening Point
Ring and Ball

Elastic Recovery



Complex Shear Modulus
and Phase Angle
-20 °C to 150 °C

# Field Trials

## Field Trial 2 - Test methods

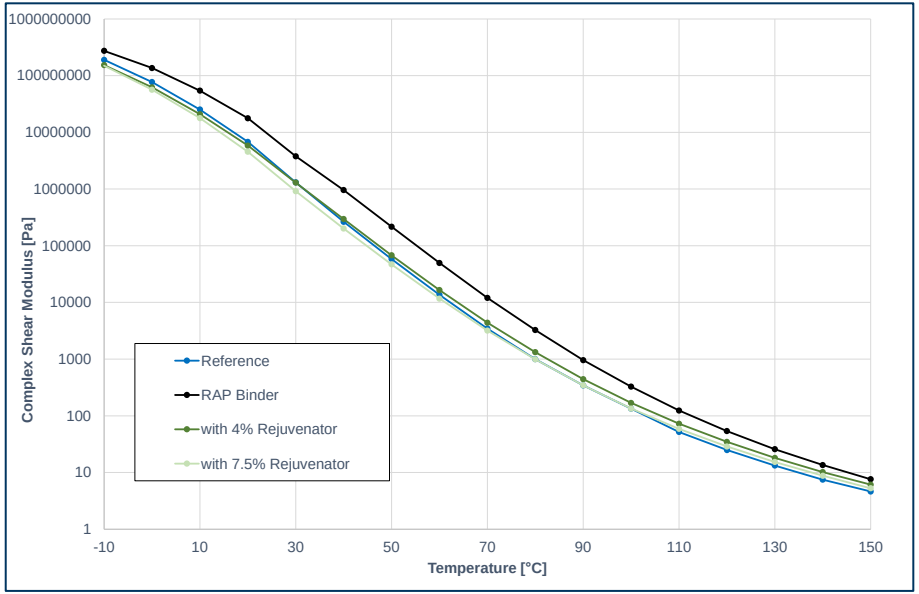
Dynamic Stiffness
at -10 °C, 0 °C, 10 °C, 20 °C

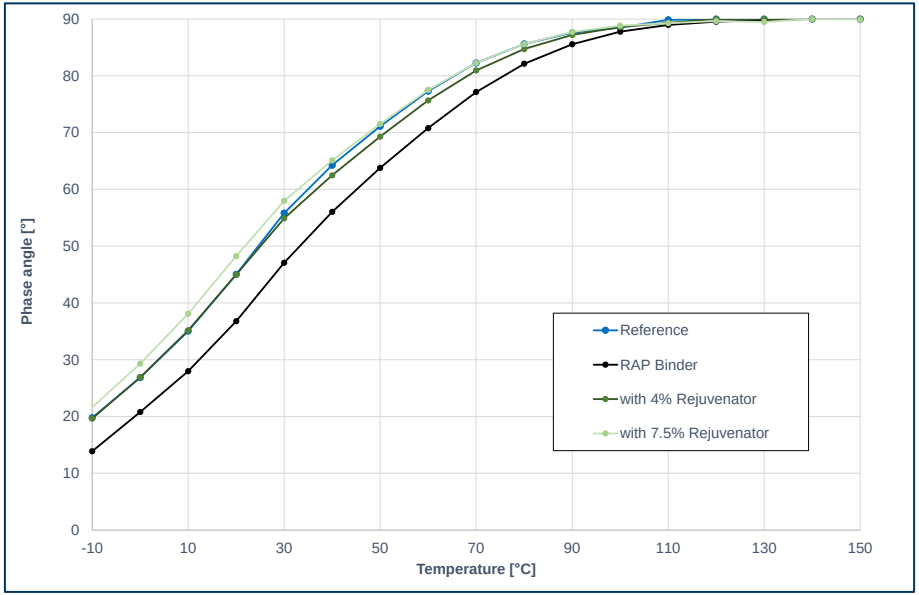
Permanent Deformation
at 50 °C

Low-Temperature Behavior
TSRS-Test

# Field Trial 1 - Results

## Field Trial 1 – Asphalt binder properties



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# Field Trial 1 - Results

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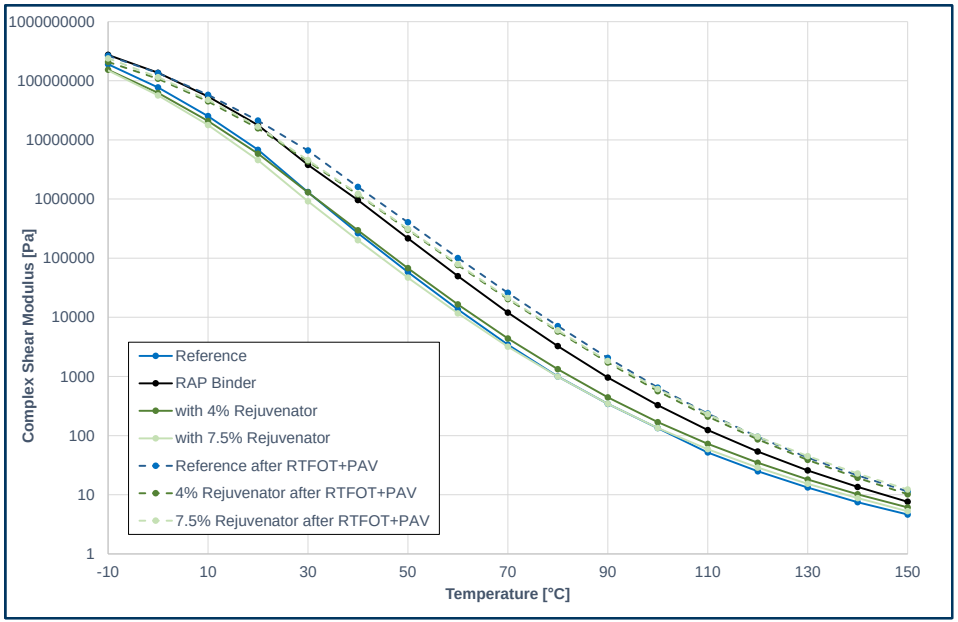




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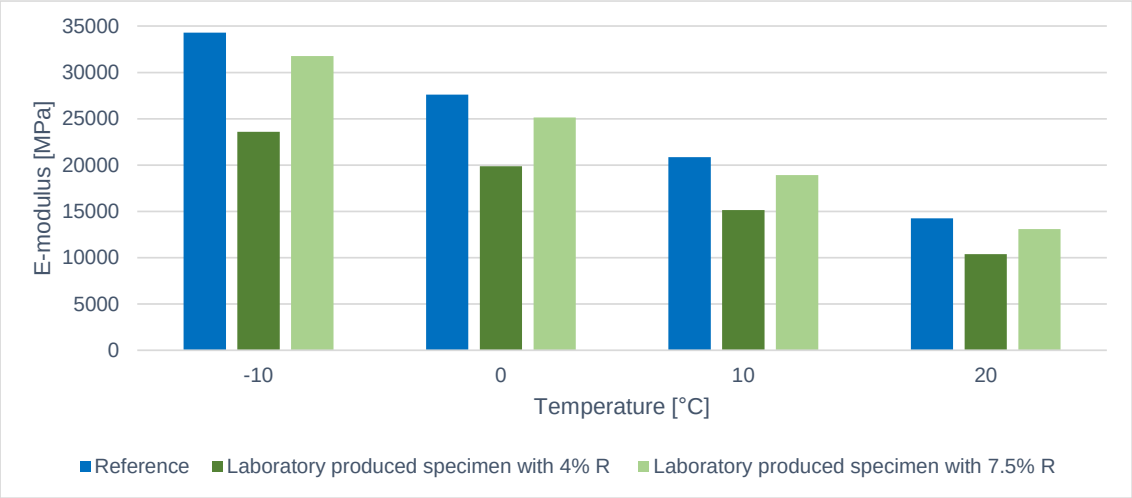
# Field Trial 1 - Results

## Field Trial 1 – E-modulus

E-modulus of the different asphalt base mixtures according to EN 12697-26 (reference with 50% RAP and the variants with 70% RAP and rejuvenator)



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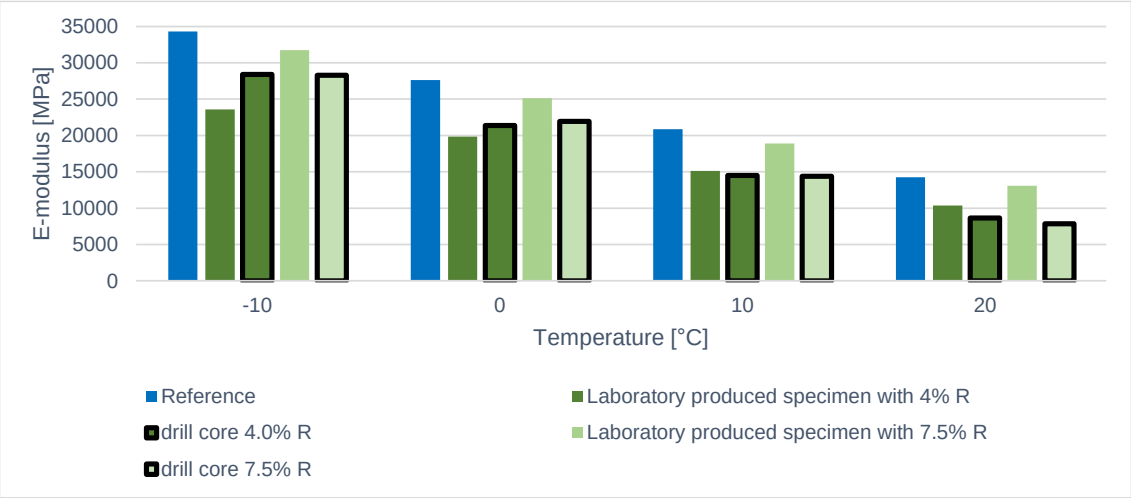

# Field Trial 2 - Results




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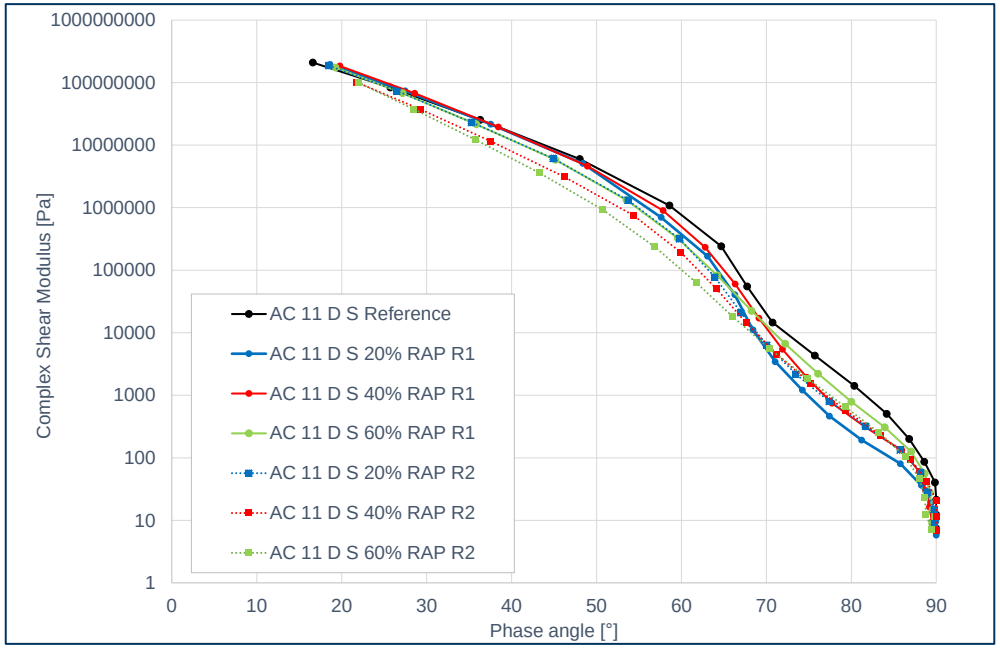
# Field Trial 2 – Asphalt binder results

| Variant | | R&B EN 1427 | Penetration EN 1426 | T (G*= 15 kPa) EN 14770 | δ (G*= 15 kPa) EN 14770 | Elastic recovery EN 13398 |
|---|---|---|---|---|---|---|
| | | [°C] | [1/10 mm] | [°C] | [°] | [%] |
| **Binder course** | **Reference** | **64.0** | **25.3** | **62.8** | **70.2** | **72** |
| | 30% RAP R1 | 65.5 | 25.9 | 64.6 | 70.5 | 61 |
| | 45% RAP R1 | 63.4 | 34.1 | 62.1 | 70.7 | 63 |
| | 60% RAP R1 | *70.6* | *19.8* | *70.7* | *70.5* | *49* |
| | 30% RAP R2 | 66.2 | 25.0 | 64.2 | 69.8 | 68 |
| | 45% RAP R2 | 63.4 | 29.0 | 62.3 | 70.0 | 61 |
| | 60% RAP R2 | 64.1 | 30.0 | 63.6 | 69.4 | 58 |
| **Surface course** | **Reference** | **61.6** | **27.6** | **59.8** | **70.7** | **74** |
| | 20% RAP R1 | 64.9 | 33.0 | 62.8 | 67.9 | 71 |
| | 40% RAP R1 | 63.5 | 35.7 | 59.7 | 67.5 | 71 |
| | 60% RAP R1 | 66.0 | 28.8 | 61.6 | 66.7 | 53 |
| | 20% RAP R2 | 66.2 | 27.4 | 63.3 | 69.6 | 66 |
| | 40% RAP R2 | 63.1 | 32.7 | 61.2 | 69.4 | 61 |
| | 60% RAP R2 | 65.1 | 33.5 | 57.7 | 67.9 | 50 |

# Field Trial 2 – Asphalt binder results



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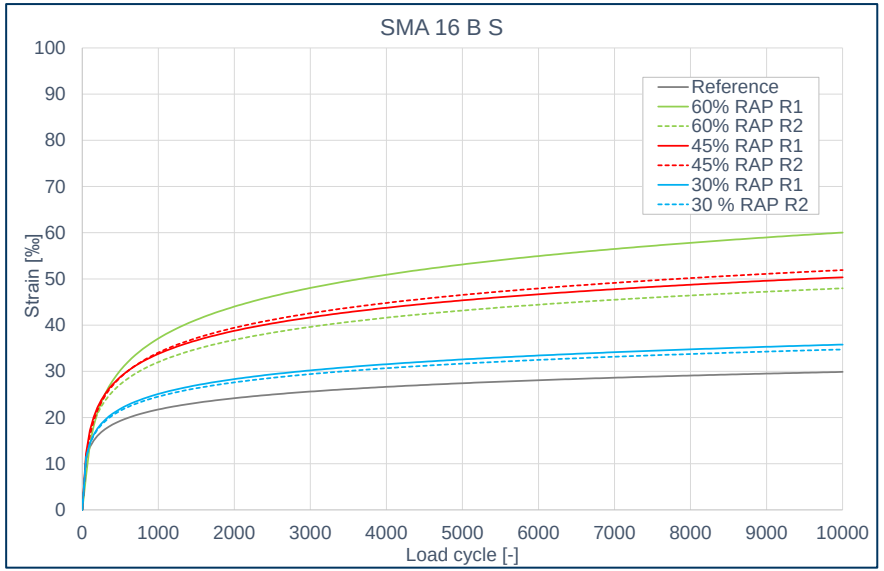
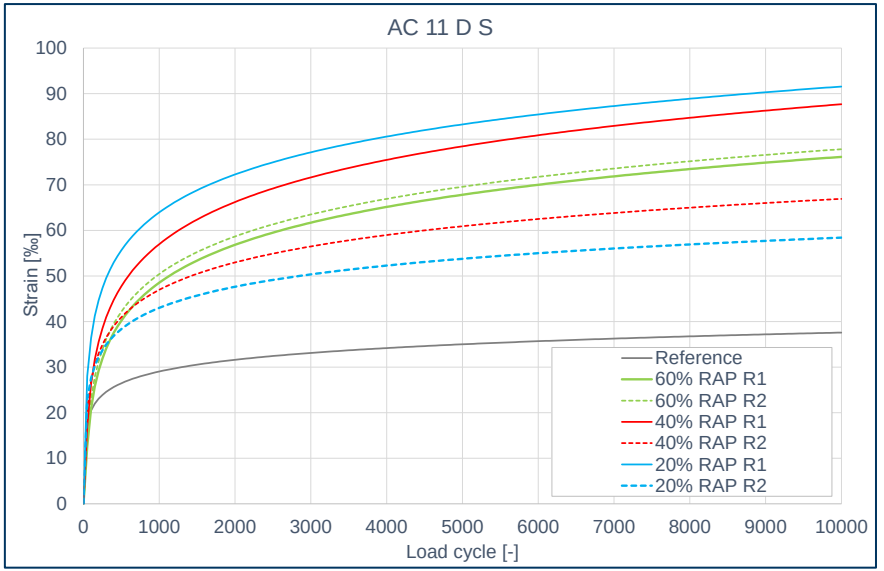
# Field Trial 2 – Asphalt Performance



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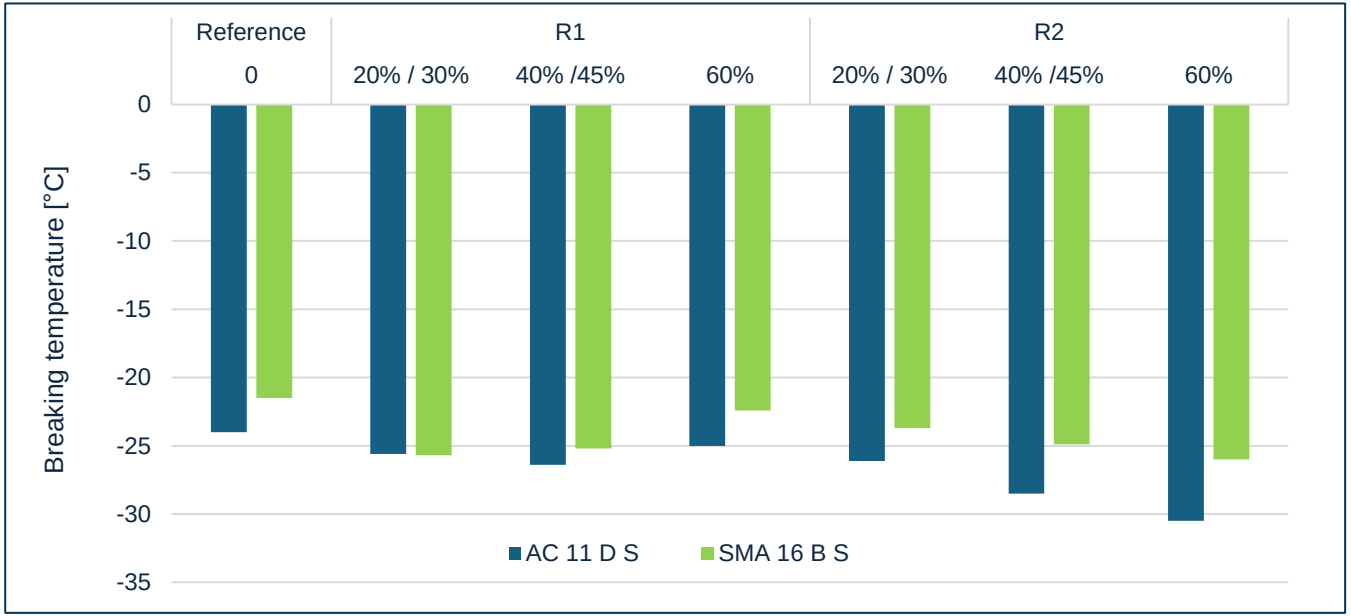
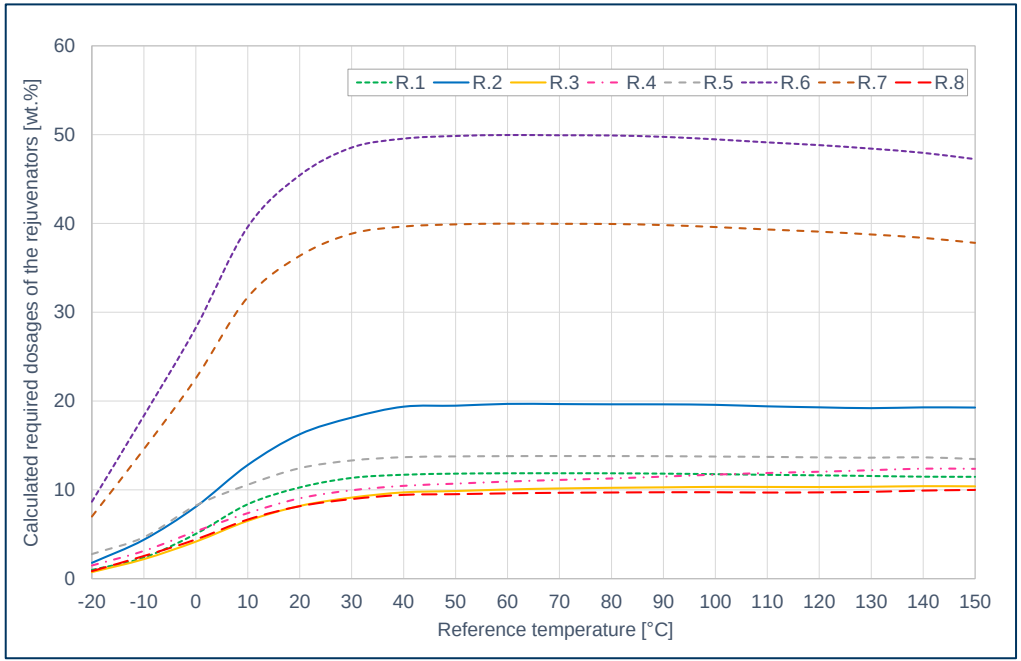


# Further Research Work

## Influence of the temperature range on the dosing of rejuvenators




K. Schwettmann, D. Stephan, N. Nytus, M. Radenberg, and S. Weigel: „Post carbon road - The endless cycle of bitumen reuse" Proceedings of the 7th Eurasphalt & Eurobitume Congress v1.1, 2021

# Conclusions

- Rejuvenators enable the addition of high proportions of RAP
- The binder properties can be precisely adjusted, particularly regarding binder stiffness. However, preliminary tests are necessary
- The influence of polymers on the elastic recovery becomes clear as the proportion of RAP increases and the proportion of fresh bitumen decreases
- Rejuvenators can have a positive effect on the cold behavior of bitumen and asphalt mixtures
- In the variants analyzed here, the variants with rejuvenators were found to have poorer resistance to deformation
- The dosage should be based on the asphalt performance and not solely on the contract parameter softening point ring and ball or equi-shear modulus temperature, which is common in Germany.