Die Autobahn

Sustainable increase in the proportion of asphalt granulat in the superstructure of highways

Experiences from the motorway A6 near Walldorf

Content

- Introduction
- Project data of the motorway A6 near Walldorf
- Results of the investigations
- Our requirements for the addition of high RAP quantites in the superstructure
- Project realisation A6 carriageway renewal Crossing Walldorf – Junktion Wiesloch/Rauenberg (direction Nürnberg)

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Autobahn and environmental protection go hand in hand! We take responsibility!

- *safety*
- *sustainability*
- *reliability*

for all motorwayusers and residents

Source: Jan R Schäfer

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Reduction of greenhouse gas emissions (GHGE)

The Autobahn GmbH des Bundes is the inalienable property of the Federal Republic of Germany and, as such, is an entity entrusted with sovereign tasks and public duties.

Greenhouse gas emissions (GHGE) must therefore be gradually reduced as follows compared to 1990, in accordance with Section 3 (1) and (2) Climate protection act:

- by at least 65 per cent by 2030
- by at least 88 per cent by 2040

The Autobahn GmbH des Bundes is one of the largest infrastructure operators in Germany – **we also take responsibility for climate targets**.

A major client at the intersection of the transport and industry sectors, Autogahn Gmbh sets a good example as a **driving force, innovation leader and promotor of new technology**.

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Project data

motorway section

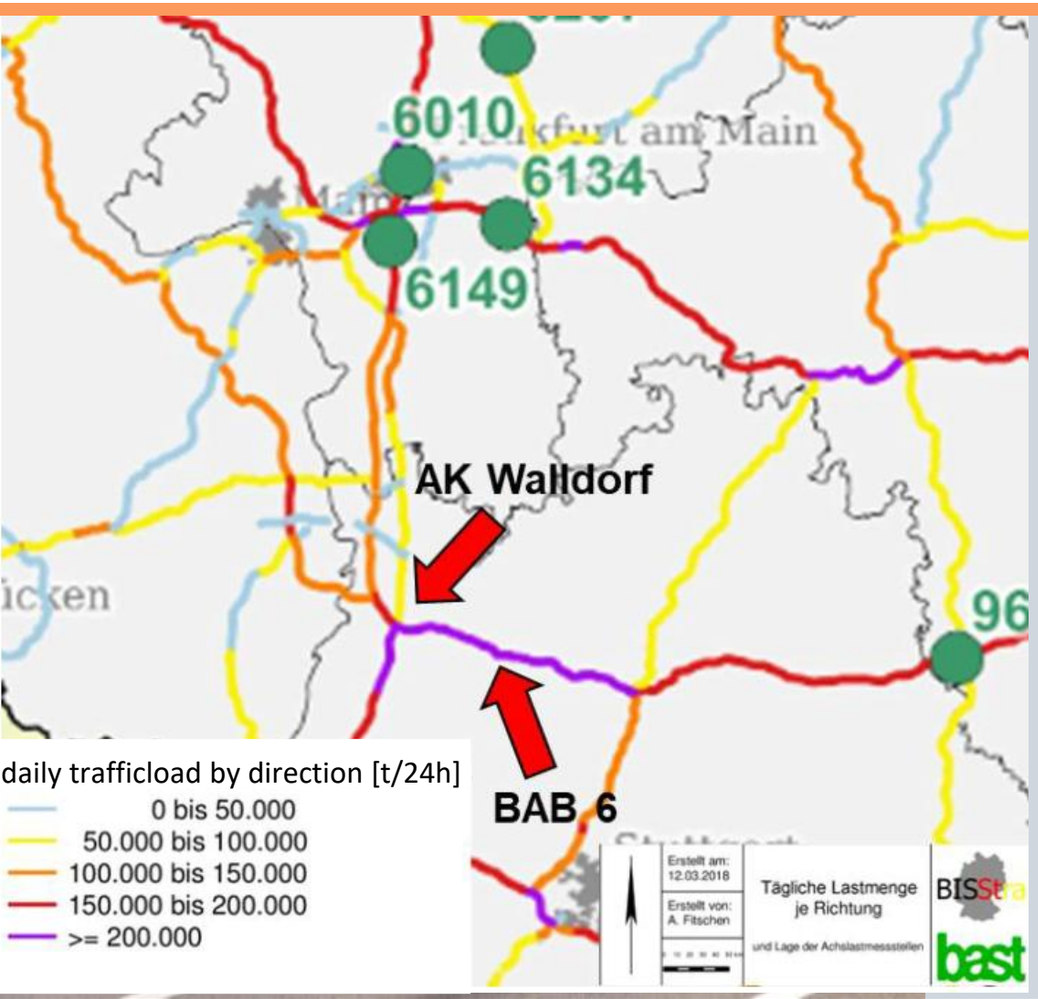
A6 inbetween motorway crossing Walldorf and junction Wiesloch/Rauenberg, direction Nürnberg

Length: about 4,5 km

junction Wiesloch/Rauenberg

motorway junction Walldorf

Project data



Short introduction of the project

last renewal: about 20 years ago

daily traffic load: about 90.000 vehicules a day, very high heavy goods vehicule traffic with aprox. 20 %

daily load volume: > 200.000 t/day

climatic conditions: very hot in the rhine valley, east-west orientation

construction performance:

- fundamental renewal in asphalt construction (soil stabilisation, asphalt basal, binder and surface layers)
- Adjustment of the height and cross gradient according the regulations, therby improving the drainage properties
- Renewal of the concret sliding walls and steel guardrails

construction time: june 2024 until december 2024

costs: approx. 15 mio €

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Investigationresults

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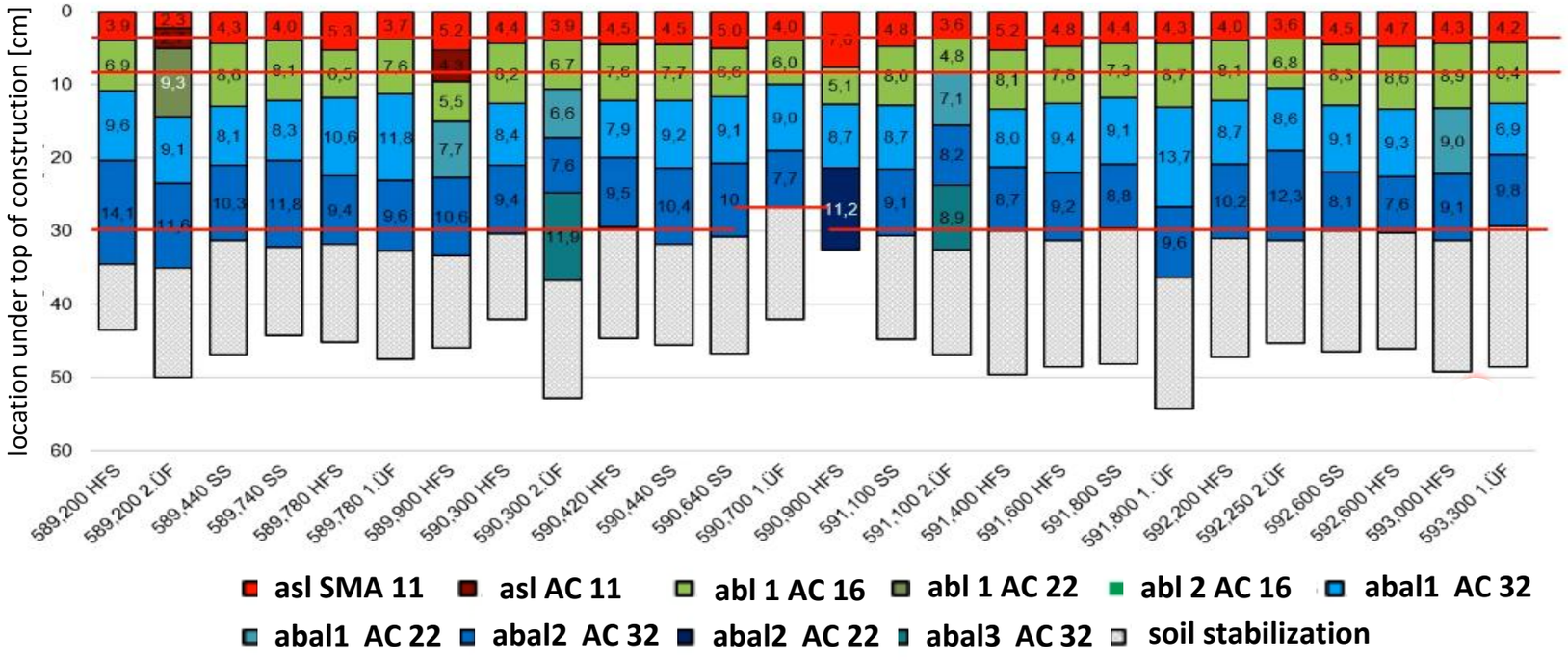
Motorway A6 between Junction Walldorf and Wiesloch/Rauenberg
layerthicknesses for RAP production - direction Nürnberg



- Sampling grid approx. every 150 m, due to the potential for reusing the asphalt in our own pilot project – emphasis was placed on the bitumen properties
- Proposal for milling horizons based on the detailed preliminary investigation (closer exploration grid)
- Remaining useful life of the asphalt base layer is too short for further use
- **The RAP is suitable for reuse on our own construction site**

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Investigationresults

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		layerthickness [cm]	area [m²]	volume [m³]	mass [t]	needed RAP [t]	RAP in stock [t]	deviation [t]
compact asphalt	**asl (asphalt surface layer)**	**2,0**	**63.000**	**1.300**	**3.250**	**1.300**	**3.750**	**+2.450**
	abil (asphalt binder layer)	**8,0**		**5.000**	**12.500**	**7.500**	**7.750**	**+250**
	abal (asphalt base layer)	**24,0**		**15.100**	**37.800**	**30.240**	**30.500**	**+260**
					total	**39.040**	**42.000**	**+2.910**
conventional construction method	asl (asphalt surface layer)	**4,0**	**63.000**	**2.600**	**6.500**	**1.300**	**3.750**	**+2.450**
	abil (asphalt binder layer)	**8,0**		**5.000**	**12.500**	**6.250**	**7.750**	**+1.500**
	abal (asphalt base layer)	**22,0**		**13.900**	**34.800**	**27.800**	**30.500**	**+2.700**
					total	**35.350** **36.650**	**42.000**	**+7.950** **+6.650**

Calculated RAP-balance

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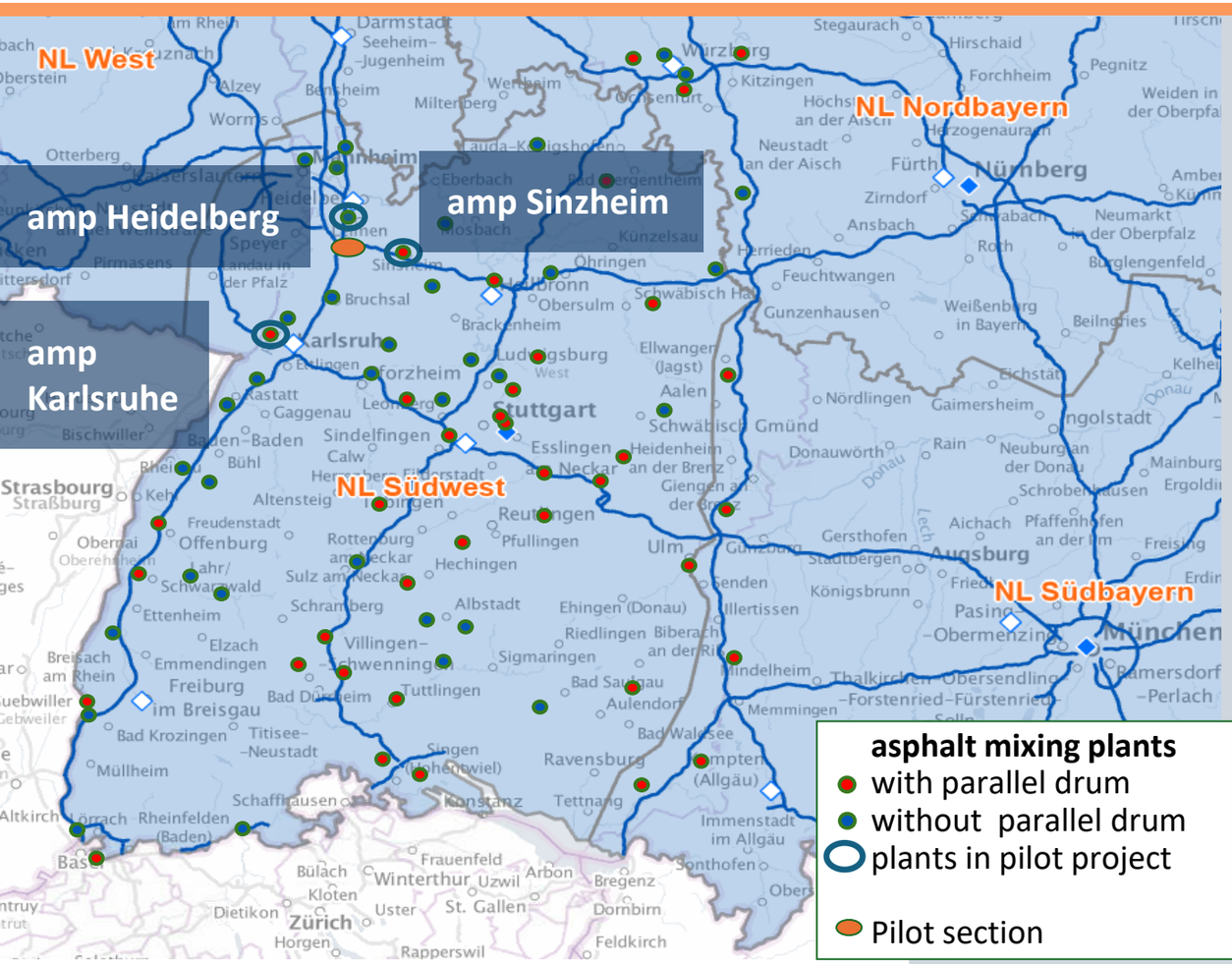
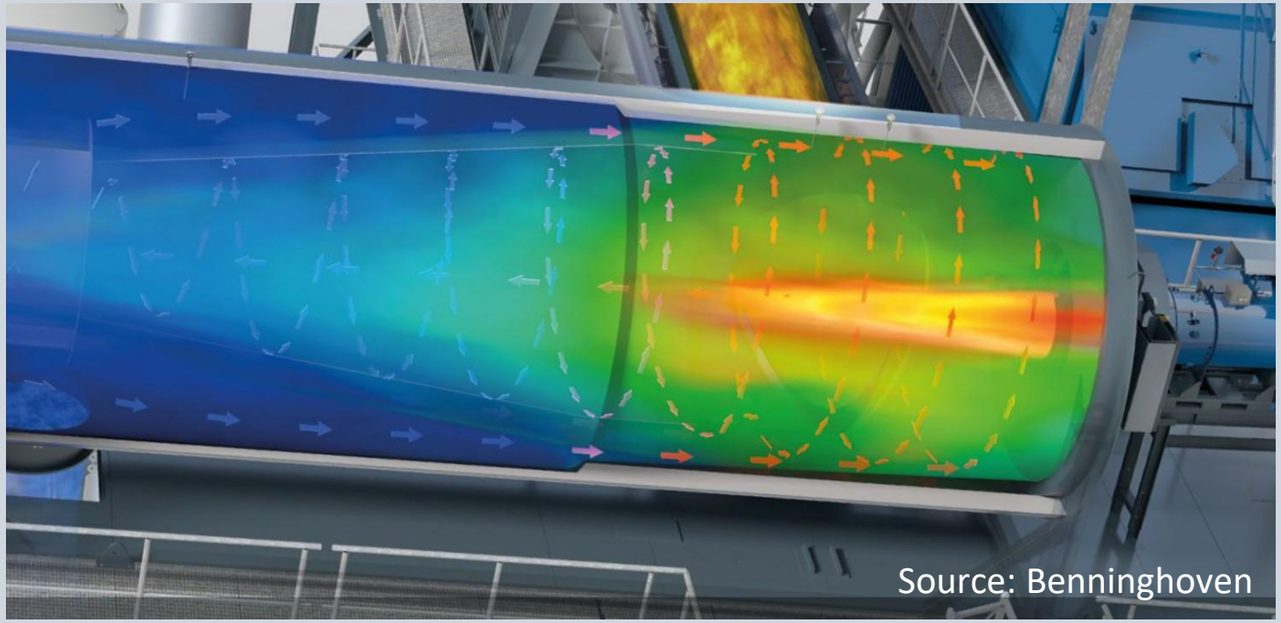
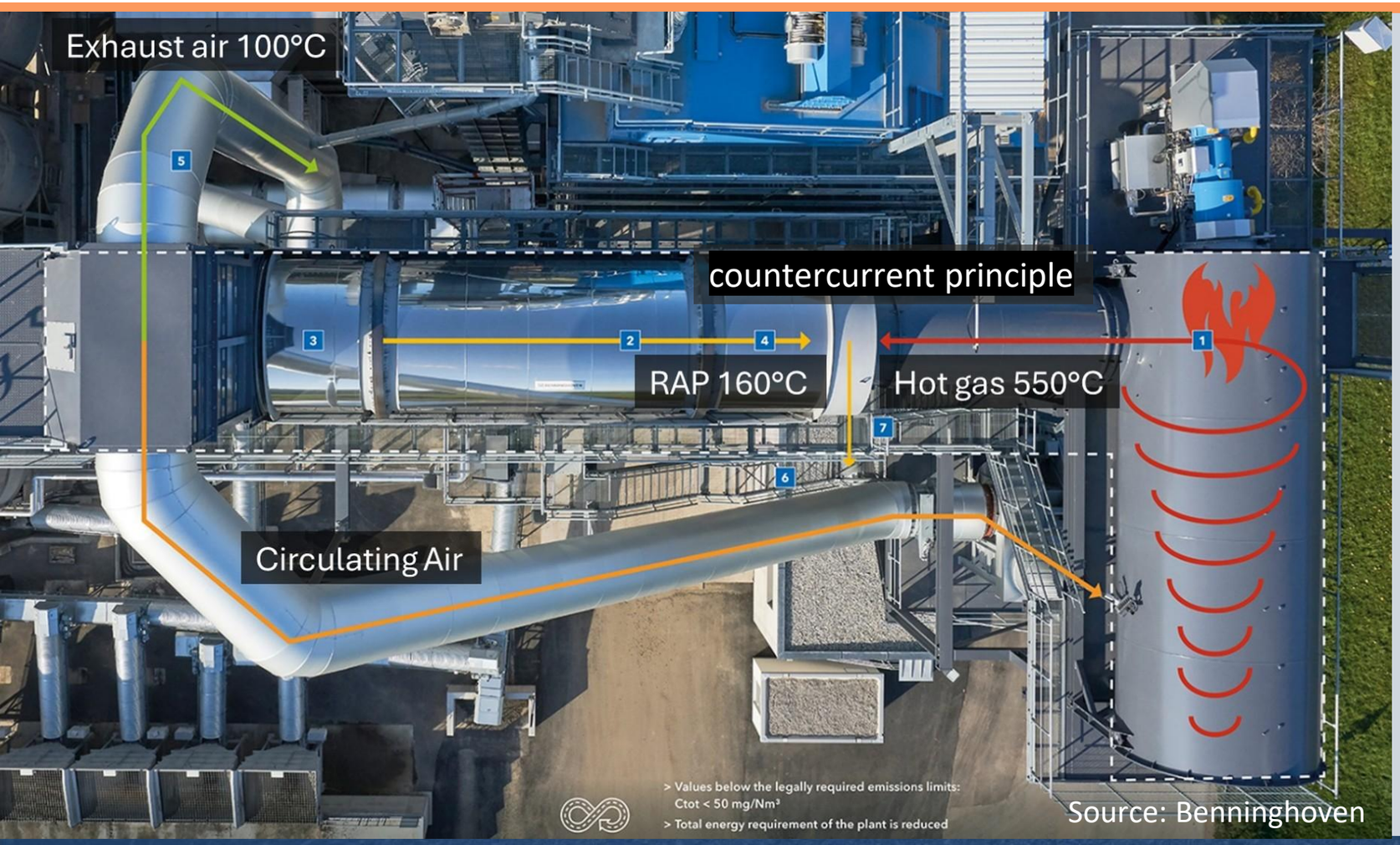
Requirements for the addition of high RAP quantities





High RAP additions possible in asphalt mixing plants with parallel drum and hot gas generators like in the asphalt mixing plants (amp) of Sinzheim and Karlsruhe

Requirements for the addition of high RAP quantities



Source: Benninghoven

Requirements for high RAP content in superstructures

Mixing plants with parallel drums (and hot gas generators) => addition of higher RAP quantities (> 40 %) possible

Addition of expanded RAP via separate device (parallel drum):

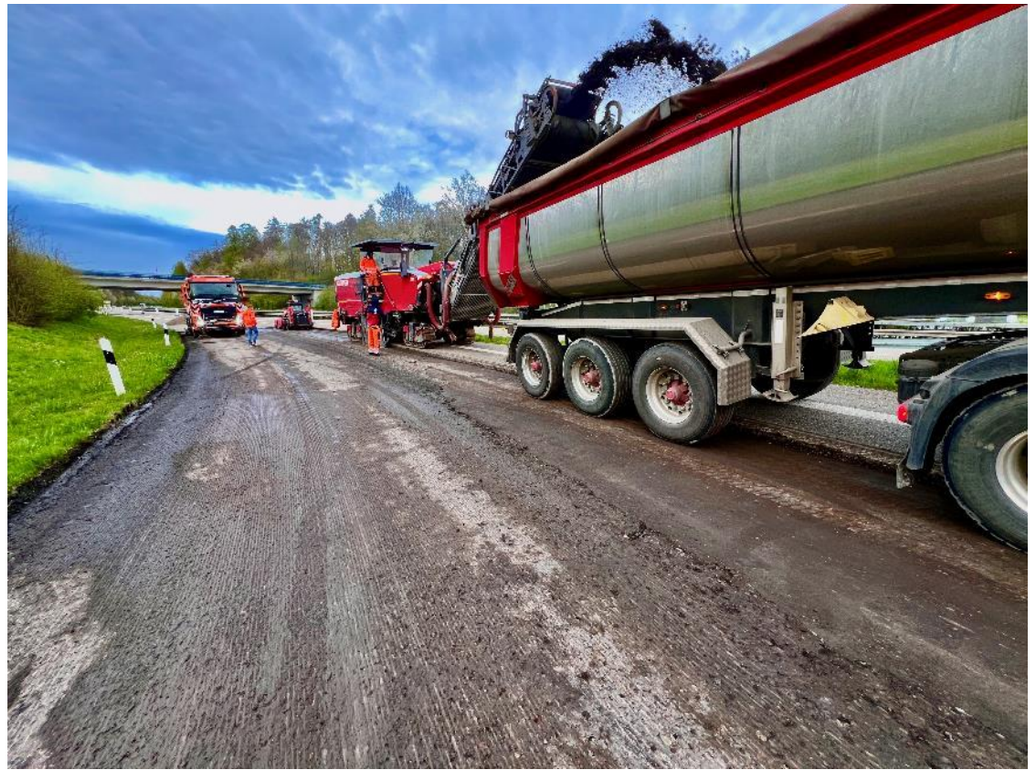
- gentle heating

- addition via extra scales into the mixer

Short contact times between the asphalt granulate and the hot rocks => relatively long remixing times

Requirements for the addition of high RAP quantities

Requirements for high-quality RAP

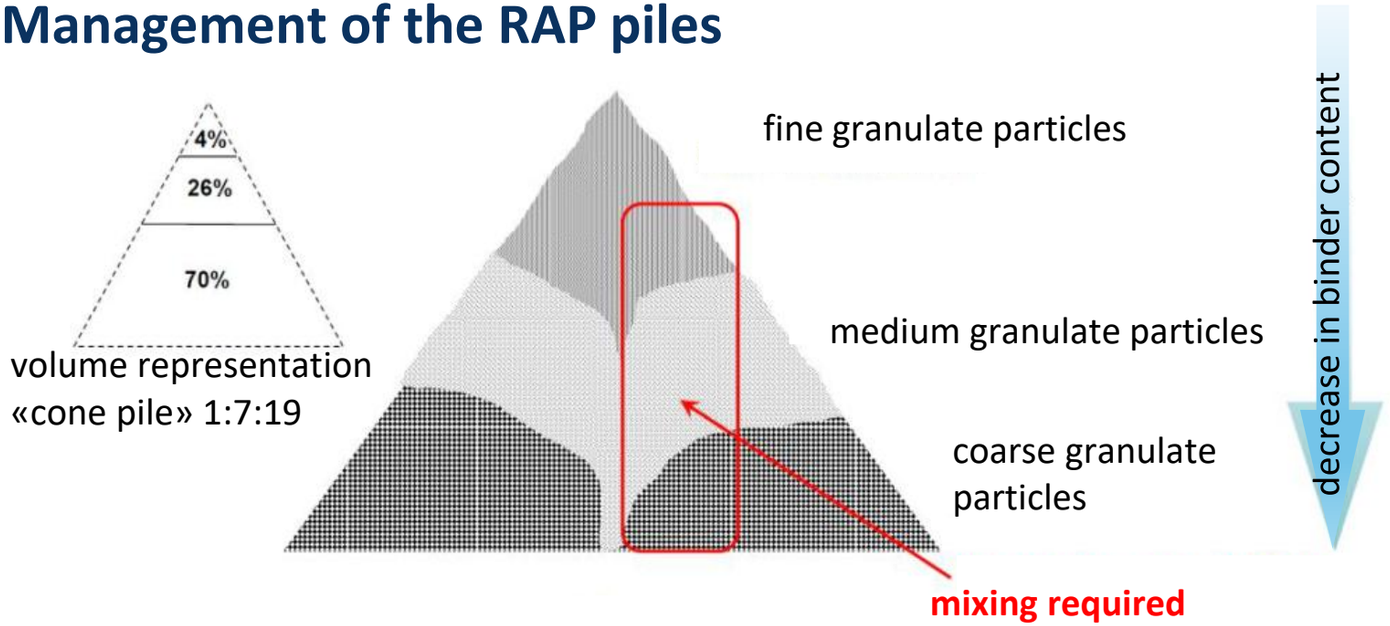


Single-type extraction of the removal granulate by **layer-by-layer milling** of the asphalt surface layer, asphalt binder layer and asphalt base layer in the **homogeneous removal sections**.

The expanded RAP from the motorway construction project is suitable and should be used => **Separate storage** until further processing, and **good stockpile management** is required.

Requirements for the addition of high RAP quantities

Management of the RAP piles



Schematic representation of a cone-shaped RAP pile (belt discharge) source [12]

A special ’RAP manager‘ from the BAG/BVG Group was installed at the mixing plant!
(not a standard)

[12] Behle, T.: „Asphaltgranulatmanagement – Betrachtung der Prozesssicherheit (Teil 2)“, Asphalt, 55, 6, pp. 14-21, Giesel Verlag GmbH, Hannover 2020.

Requirements for the addition of high RAP quantities

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B-Zahl $B = N \cdot DTA^{(SV)} \cdot q_{Bm} \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_z \cdot 365$

B	**Dimensioning-relevant stress B** **Equivalent 10-tonne axle loads during the assumed period of use**	
$DTA^{(SV)}$	**Average number of daily axle crossings by heavy goods vehicles**	**$DTA^{(SV)} = DTV^{(SV)} \cdot f_a$**
$DTV^{(SV)}$	**Heavy goods vehicles per 24 hours**	**17.469 *)**
N	**Service life**	**50 Jahre**
q_{Bm}	**Average load collective quotient**	**0,4632 **)**
f_A	**Average number of axles per heavy goods vehicle (axlefactor)**	**4,5**
f_1	**Lane factor**	**0,5**
f_2	**Lane width factor**	**1,10**
f_3	**Gradient factor**	**1,00**
f_z	**Average annual growth factor for heavy goods traffic**	**1,5 %**

- **B = 538,6 mio. equivalent 10-t-axle crossings**

*) Permanent counting station Walldorf, 2019
**) q_{Bm} by ‘RDO 09 Asphalt‘ axle load distribution ‘BAB long-distance traffic‘

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Computonal calculated dimensioning

by ‘Guidelines for the calculation of the superstructure of traffic areas in asphalt constructions ‘ (‘RDO Asphalt 09‘)

Designed for a **service life of 50 years** (normally 30 years)

Requirements for the addition of high RAP quantities

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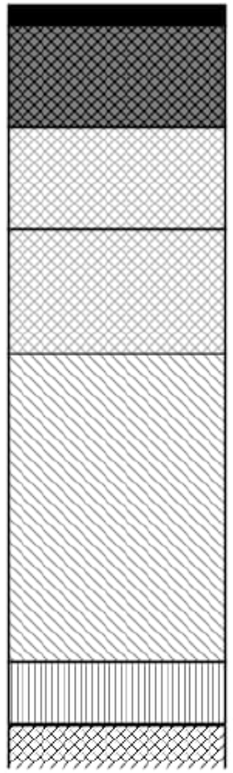
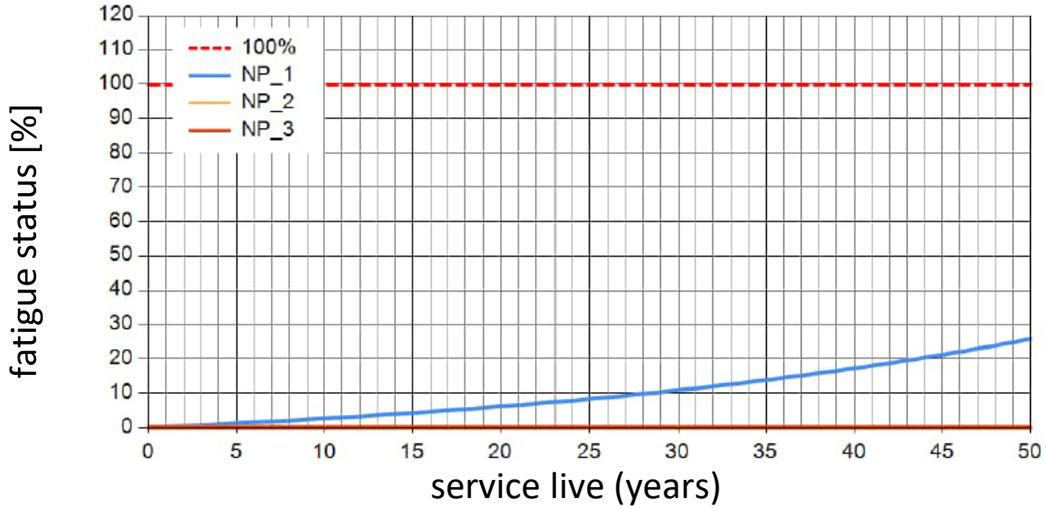
Calculated dimensioning



20 mm	asphalt surface layer (AC 8 D SP 10/40-80 VL)	
	asphalt binder layer (AC 16 B S 10/25-80 VL)	
100 mm	asphalt base layer (AC 22 TS 20/30)	
100 mm	asphalt base layer (AC 32 TS 20/30)	
120 mm	consolidation (hydraulicaly bound base layer)	
300 mm	base layer without binder	
60 mm	soil	
700 mm		

The new carriageway was computational dimensioned in accordance with the ‘Guidelines for the calculation of the superstructure of traffic areas in asphalt constructions’ (‘RDO Asphalt-StB’). Almost all of the removed RAP has been processed in the mixing plants for reinstallation on the same construction project.



Very low fatigue status after 50 years due to the soil stabilisation under the 3 cm thicker asphalt base layer

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Realisation of the Projekt

Implemanted requirements during the trial period from June to early November 2024

- Warm mix asphalt
- Criteria of the new additional technical contract conditions (ZTV Asphalt 20xx) and technical delivery conditions (TL Asphalt 20xx) already applied through individual contractual provisions
- Standard - Quality road construction motorway asphalt (QAA 4.0) for the quality assurance
- Performance tests for suitability tests and control tests
- Results of all control tests are not yet all available

Source: BAG/BVG-Group

Realisation of the Projekt

Warm mix asphalt (wma) - better health protection, lower CO_2 emissions

- From 1 January 2027: new statutory occupational exposure limit for vapours and aerosols from hot processing of bitumen
- This will make wma the standard construction method in motorway constructions (already the case in the southwest branch today)
- New bitumen technologies and additives allow the temperature to be lowered during production (in some cases with a higher CO_2 factor) and installation of the asphalt
- Depending on the additives, often a significant reduction in CO_2 is possible => **improvement in the carbon footprint of a construction project possible**
- Higher demands on the prozess control, because there is less time after paving for the compaction

Realisation of the Projekt

Compact asphalt

- Paving of binder and surface layers as well as pre-compaction in a single pass (‘warm on warm’; using Inline Pave paving trains)
- This results in **high quality of the layer bond**, optimised paving results and **longer durability of the new carriageway**
- Faster and more efficient installation; compact asphalt can help to shorten construction time and minimise restrictions
- Possible, sensible addition to warm mix asphalt installation, as compact construction cools down more slowly (more time for compaction of the layers)
- Longer durability means:
  - Fewer construction sites
  - Less traffic jams
  - Less stress on people and the environment

Realisation of the Projekt

At the southwest branch process control is implemented by the guideline Quality road construction Motorway Asphalt 4.0 (‘QAA 4.0’)

‘QAA 4.0’ enables **flexible and more reliable process control; construction processes are optimised**

- The central processes of production, transport, paving and compaction are digitised, networked and coordinated in real time
- Installation targets and progress, asphalt temperature, position of delivery lorries and other data are thus always visible
- **Optimised processes enable:**
  - **Improved paving quality**
  - **Longer durability of the carriageway**
  - **Less traffic jams**
- ‘QAA 4.0’ is both economical and sustainable (greater resource efficiency, less need for maintenance requirements)

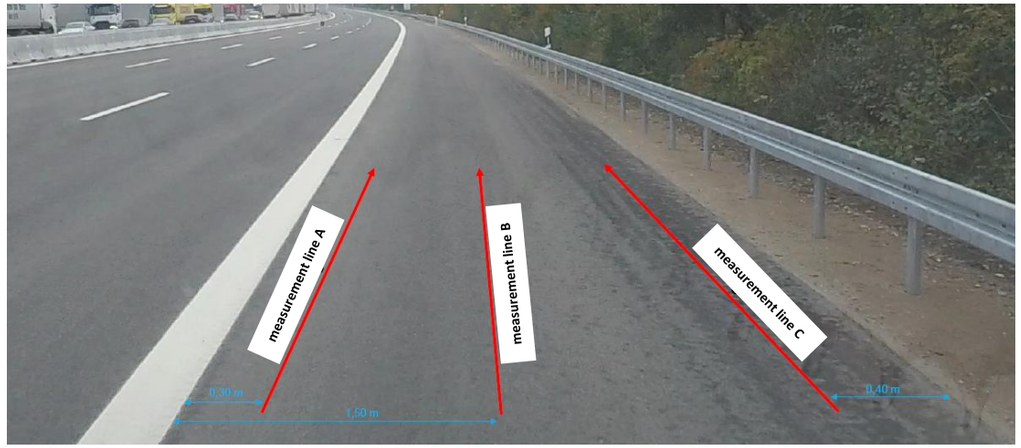
Realisation of the Projekt


Source: Sabine Mayer BAG

Challenges during construction

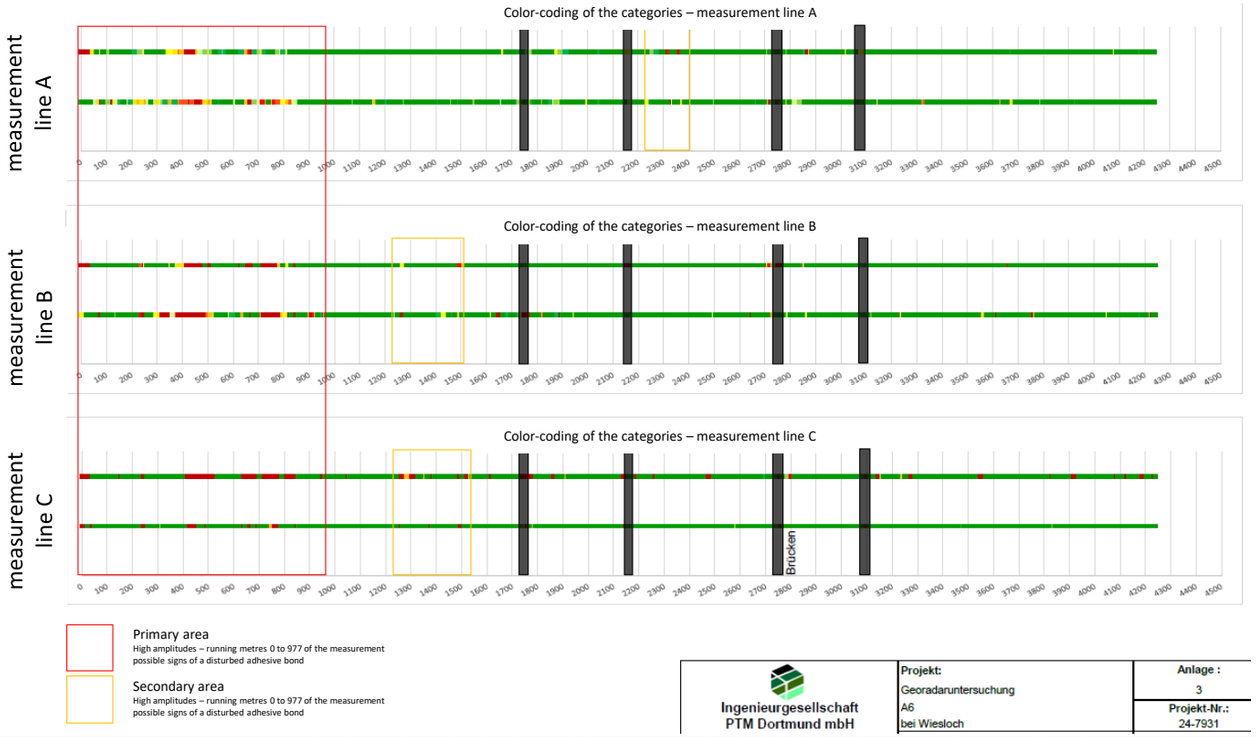
Logistics of the construction project through the use of our own RAP

- Processing at the mixing plants:
  - Need of time for the crushing process
  - Preparation of the initial inspection
  - Performance tests for the proof of suitability
- Transport and mixing logistics during installation
- Location after motorway junction and Traffic management (4+0) without hard shoulder => many accidents and resulting traffic jams
- Without delays the planned construction schedule was adhered
- Luck with the weather



Insufficient layer bonding

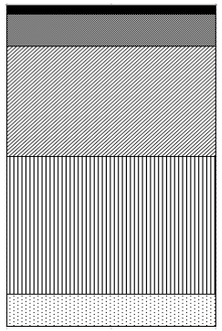
- **During the control tests, it was determined that the layer composite did not meet the requirements over a length of approximately 600 m in the hard shoulder area**
- Investigation using ground-penetrating radar by engineering firm PTM Dortmund GmbH
- 98 drill cores have already been extracted from the carriageway along the 4.5 km construction site; further drill cores would have been necessary to narrow down the area



Realisation of the Projekt

This happened in the construction project during the period from June to early November 2024

- reuse of the milled **own** RAP
- maximum recycling
  - Asphalt surface layer 40% RAP
    (PmB 10/25 VL ready-mixed binder with wax)
  - Asphalt binder layer 60% RAP
    (PmB 10/25 VL ready-mixed binder with wax)
  - Asphalt base layer 80% RAP
- Adjustment of cross slope
- Dimensioning by ‘RDO Asphalt 09‘
- Therefore **almost 100% of the own RAP was reused in the same construction cite!**
- Use of standard-bitumen



2,0 cm	Asphalt surface layer AC 8 D SP	} **compact**
10,0 cm	Asphalt binder layer AC 22 B S SG	
22,0 cm	Asphalt base layers 10,0 cm AC 22 TS 2,0 cm AC 32 TS	
30,0 cm	Consolidation, widley graded building material mixture 0/45	
6,0 cm	Layer of frost-resistant material, wide or intermittently graded E_{V2} ≥ 70 MPa	
70,0 cm	**Total thickness**	

A1: Raw material extraction
A2: Transport
A3: Manufacturing
A4: Transport
A5: Construction
B1: Use
B2: Maintainance
B3: Repair
B4: Replacement
B5: Refurbishment
C1: Demolition
C2: Transport
C3: Waste Processing
C4: Disposal
D: Material Reuse

Product
Con-struc-tion
Use
End of Life
Benefits and Loads

Cradel to Gate
Cradel to Practical Compltion
Cradel to grave
Whole Life Carbon Assesment

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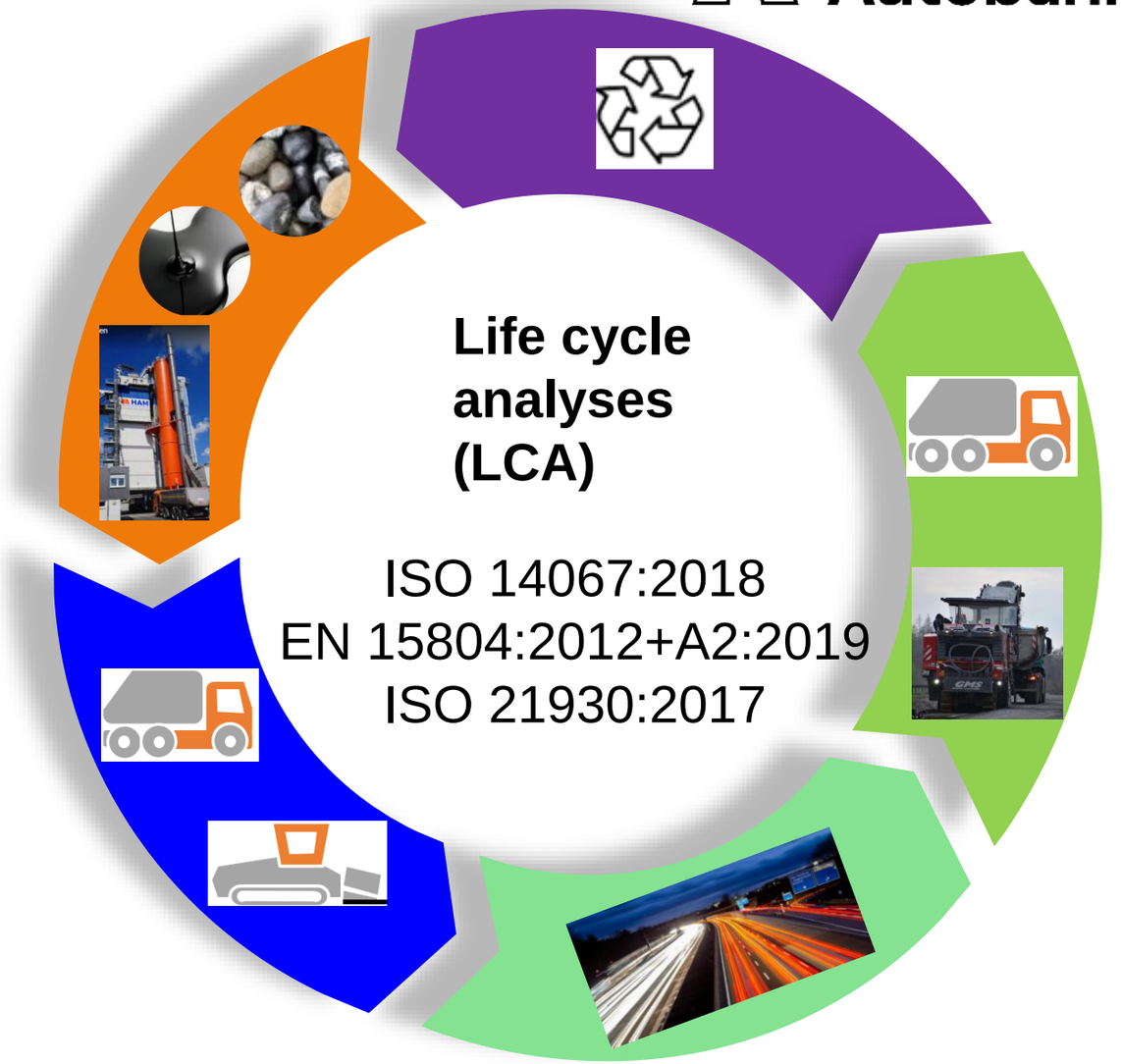

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Thank you for your attention

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