



Cold Recycling using BSM; trial section on the German motorway A555

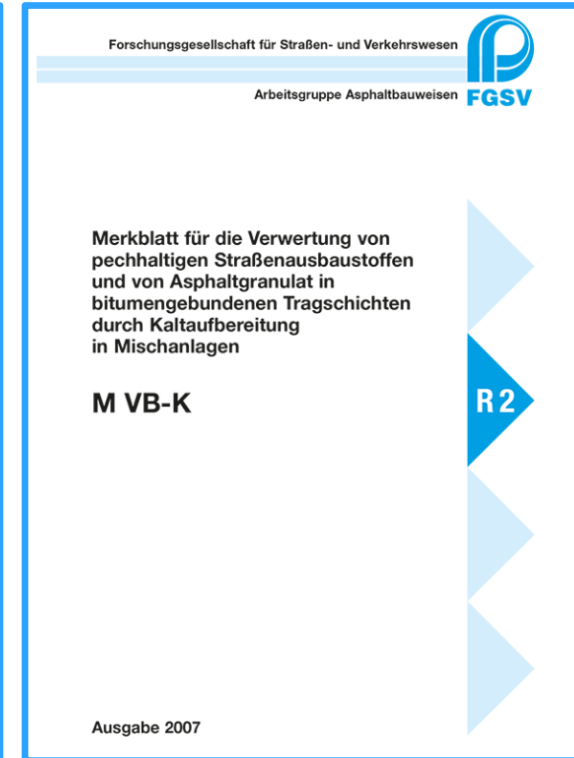
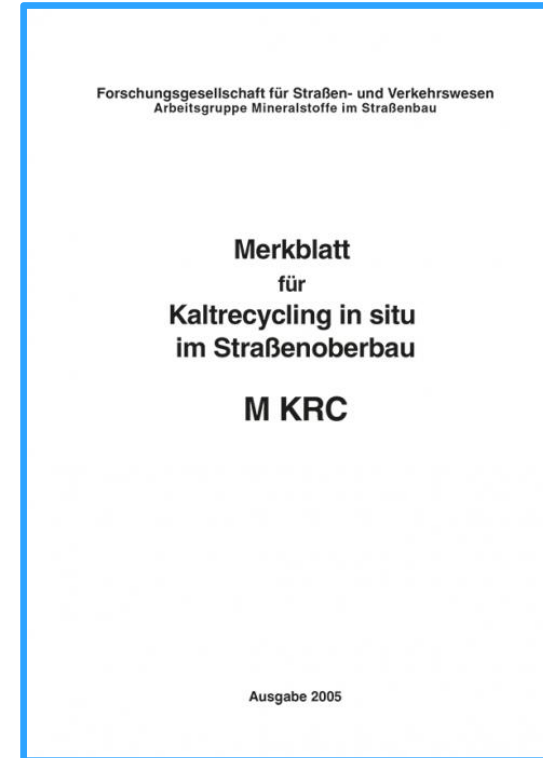
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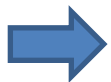
Cold Recycling in Germany

- Cold recycling in Germany is regulated by two relatively old standards
- Recycling of unbounded and bounded existing layers
- Bitumen-dominant mixture (up to 5.0 % foam bitumen; up to 6.0 % bitumen emulsion)
- Cement-dominant mixture (up to 6.0 % cement)
- Cold recycling is intended for lower pavement layers, without any substitution of the asphalt layers
- Usage permitted only for low trafficked roads (up to the 1.8 Mio. of equivalent 10 t axles); no permitted for highways
- Rarely usage in Germany, mostly for secondary road network



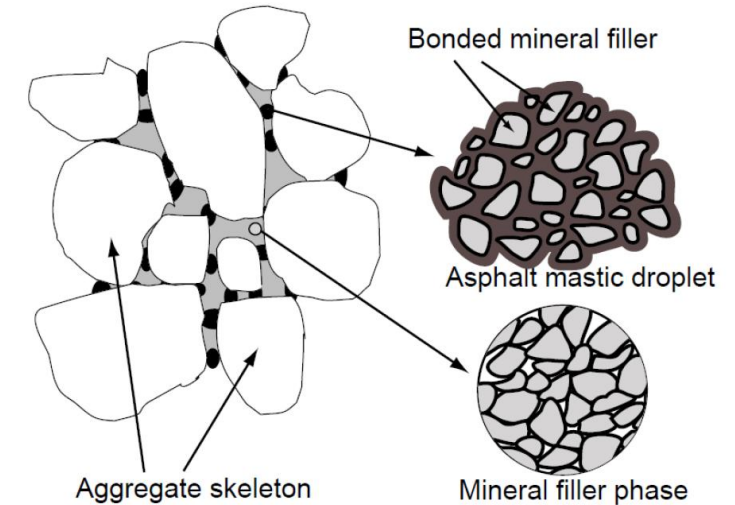
Bitumen Stabilised Material - BSM

- Different material if comparing to the previous cold mixtures; unbound nature
- Material effectively dissipates applied traffic loads through particle-to-particle contact
- Not regulated in the German standardization
- Only few trial sections in Germany (e. g. DuraBAST)
- Internationally, there is already experience with BSM as a replacement for asphalt base and asphalt binder courses
- Many projects have been already implemented in other European countries
- Recycling either in situ or in plant



**Great opportunity for BSM towards sustainability
(conservation of natural resources and reducing
the greenhouse gas emission)**

P. Fu, 2009



Content



Project Information



Project Information

GERMANY

HIGHWAY



STRABAG
WORK ON PROGRESS

 **Die
Autobahn**

**DEUTSCHE
ASPHALT**

BMTI

SAT

TPA

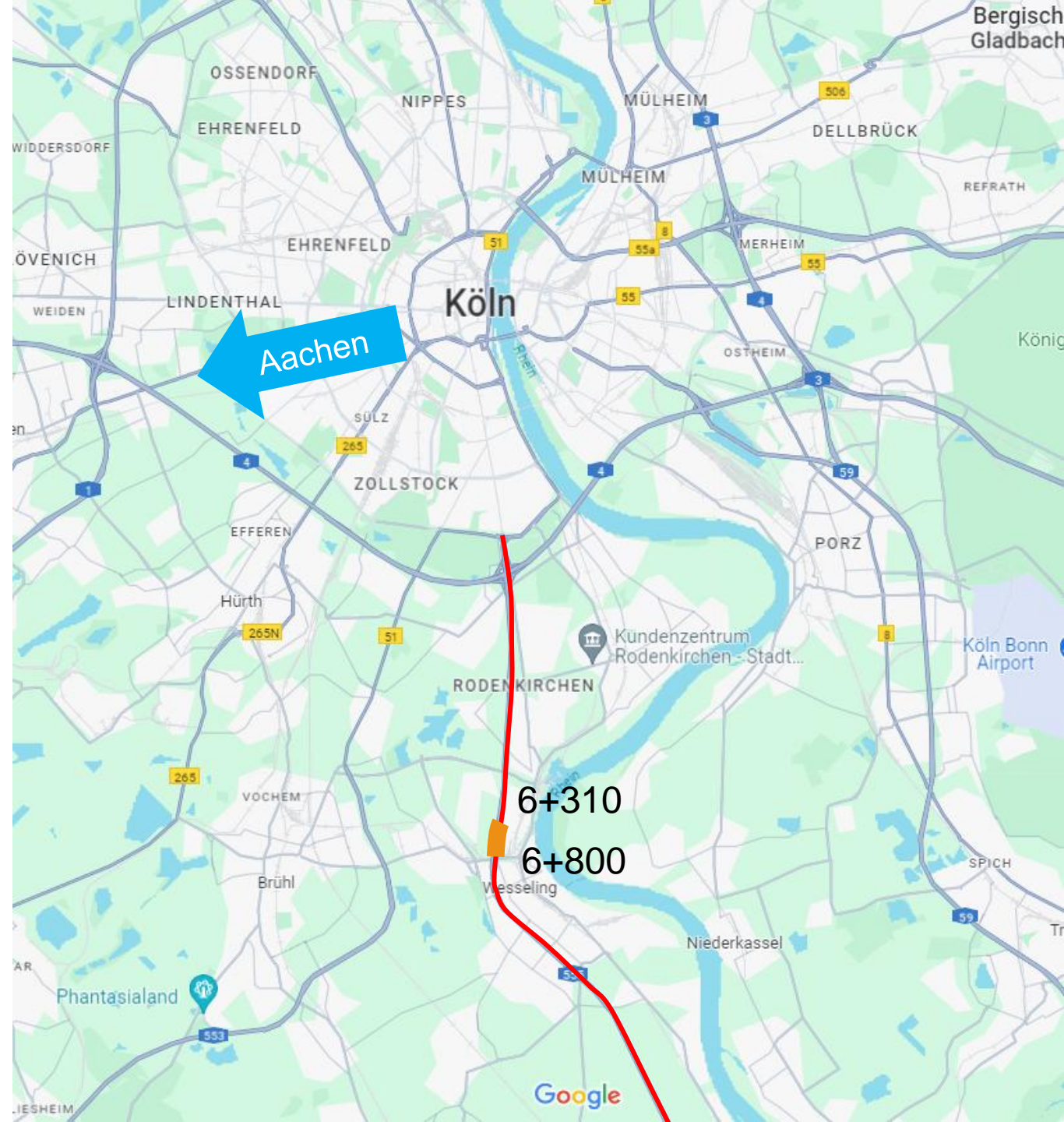
 **WIRTGEN GROUP**

ALP
LOUDON
INTERNATIONAL

bast
Bundesanstalt für
Straßenwesen 

Project Information

- First installation of BSM on public roads in Germany
- Construction of BSM in the emergency lane in 500 m test section, lane width 3.5 m
- Comparison to the reference section acc. to the German regulation possible
- Construction end of Mai 2023
- Traffic load from 23.10.2023
- Due to the construction works, emergency lane fully loaded for the next 2 years



Project Information

Existing Pavement

- ~~concrete slabs~~
- ~~cement stabilized base course~~
- unbounded gravel

Recycling in plant necessary

Project Information

- Usage of the Catalogue proposed by Loudon International
- Load class acc. to RStO 12/24: Bk100
- **BSM** pavement construction:
 - 25 - 30 cm stabilisation of the unbounded gravel with cement
 - 26 cm BSM in two layers (16 + 10 cm)
 - 4 cm SMA 11 S
- **Reference** pavement construction:
 - 25 - 30 cm stabilisation of the unbounded gravel with cement
 - 30 cm asphalt in three layers

2.2 HMA / BSM base course with hydraulic binders on layer of non-frost-susceptible material	Load class		BK100				BK32				BK10			
	B (million E ₁₀₀)		>32				10 - 32				3.2 - 10			
	Thickness of frost resistant pavement		55	65	75	85	55	65	75	85	55	65	75	85
	PAVEMENT STRUCTURE		RStO 12				RStO 12				RStO 12			
	HMA Surfacing		12				12				12			
	HMA Base		18				14				10			
	BSM Base		15				15				15			
	Stabilized granular material		5				5				5			
	Thickness of layer of non-frost-susceptible material		HMA				HMA				HMA			
			10	20	30	40	14	24	34	44	18	28	38	48
			5	15	25	35	10	20	30	40	15	25	35	45
			BSM				BSM				BSM			
			5	15	25	35	10	20	30	40	15	25	35	45

Initial Type Test



- Initial type test performed at the TPA Laboratory in Cologne
- Usage of Wirtgen equipment for BSM
- Existing RAP material from the mixing plant (RA 0/22)

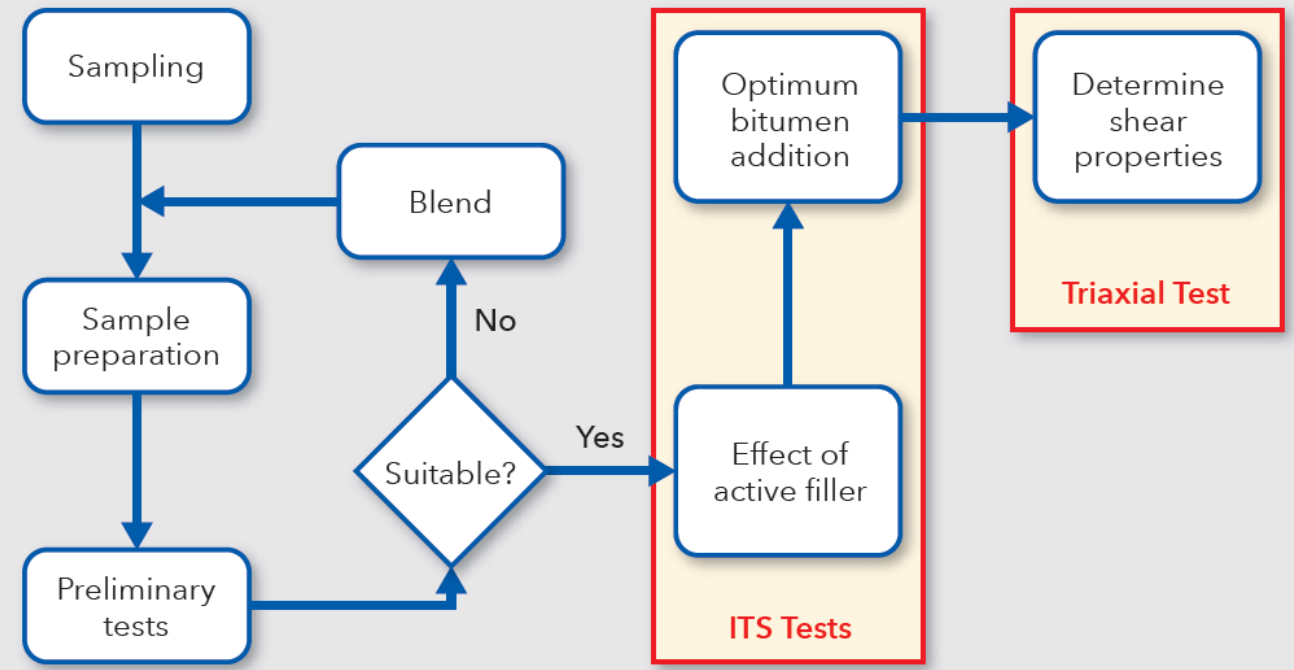


Initial Type Test



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Mix Design Flowchart



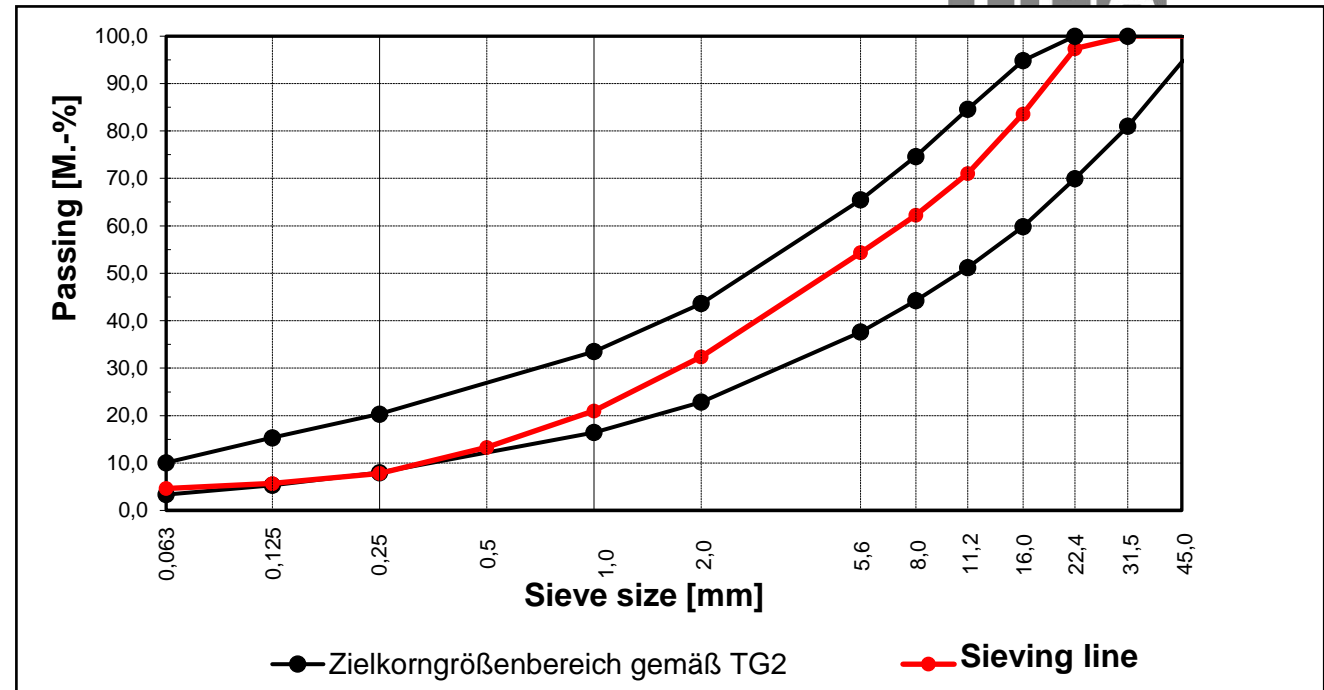
Initial Type Test

Laboratory work:

- Preliminary test:
 - low activity of RAP
 - blending with 0/5 fresh material to achieve the necessary sieving line acc. to Wirtgen Laboratory Handbook;
- Proctor test
- Two active filler used: limestone and cement
- ITS and Triaxial testing
- Final BSM mixture with:
 - **2.0 % foam bitumen**
 - **1.0 % cement**

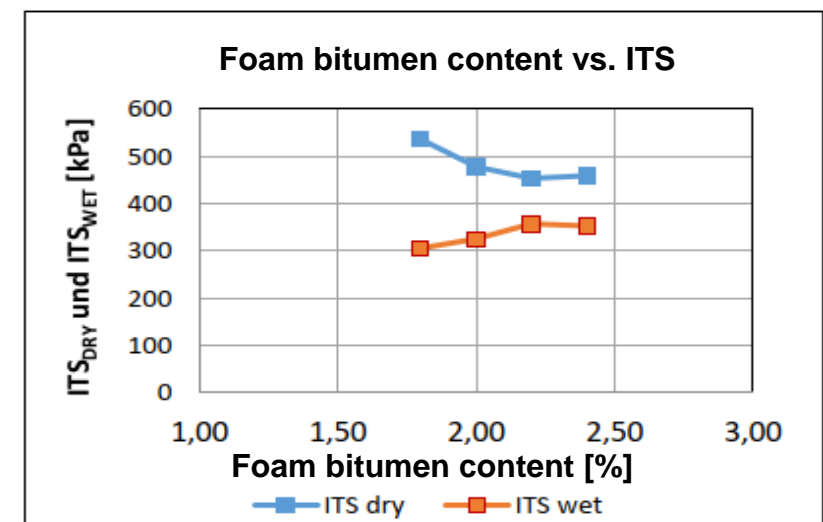


BSM1 class acc. to TG2



	ITS _{DRY} [kPa]	ITS _{WET} [kPa]
BSM1	> 225	> 125
BSM2	> 175	> 100

2.0 M.-%	
ITS _{DRY}	ITS _{WET}
478 kPa	325 kPa

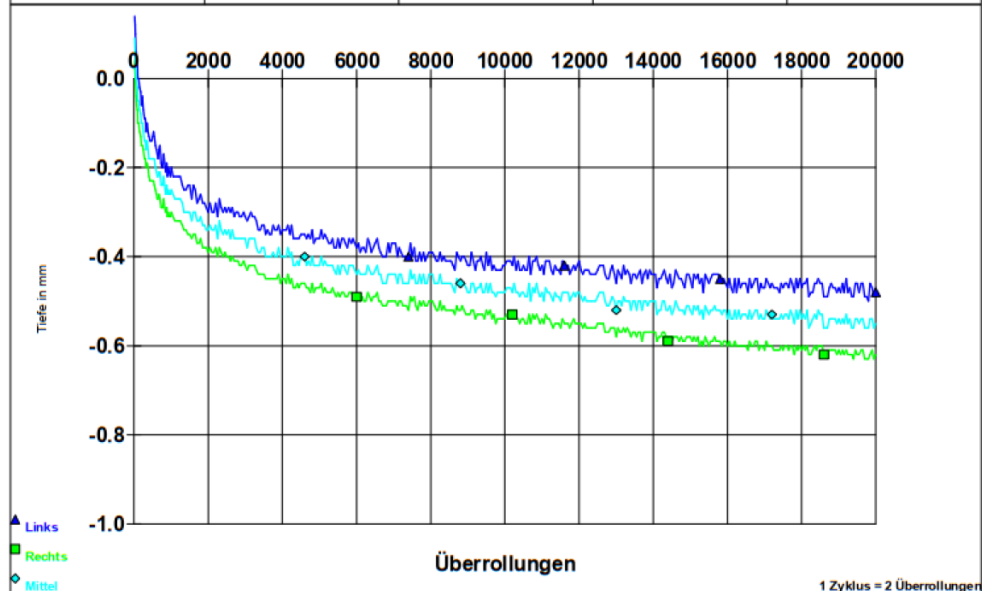


Initial Type Test

Laboratory work:

- Wheel-Tracking-Test
- Ruth depth 0.6 mm

Probe	Spurbildungsrate [mm/1000Zyklen]	Spurbildungsrate (linearer Teil) [mm/1000Zyklen]	Spurrinnentiefe [mm]	prop. Spurrinnentiefe [%]
Links	0.01 (d10000-d5000)	0.03 (d4250-d2250)	0.5 (d10000)	0.6 (d10000)
Rechts	0.02 (d10000-d5000)	0.02 (d9775-d7775)	0.6 (d10000)	0.8 (d10000)
Mittelwert	0.01	0.02	0.6	0.7



BSM Production



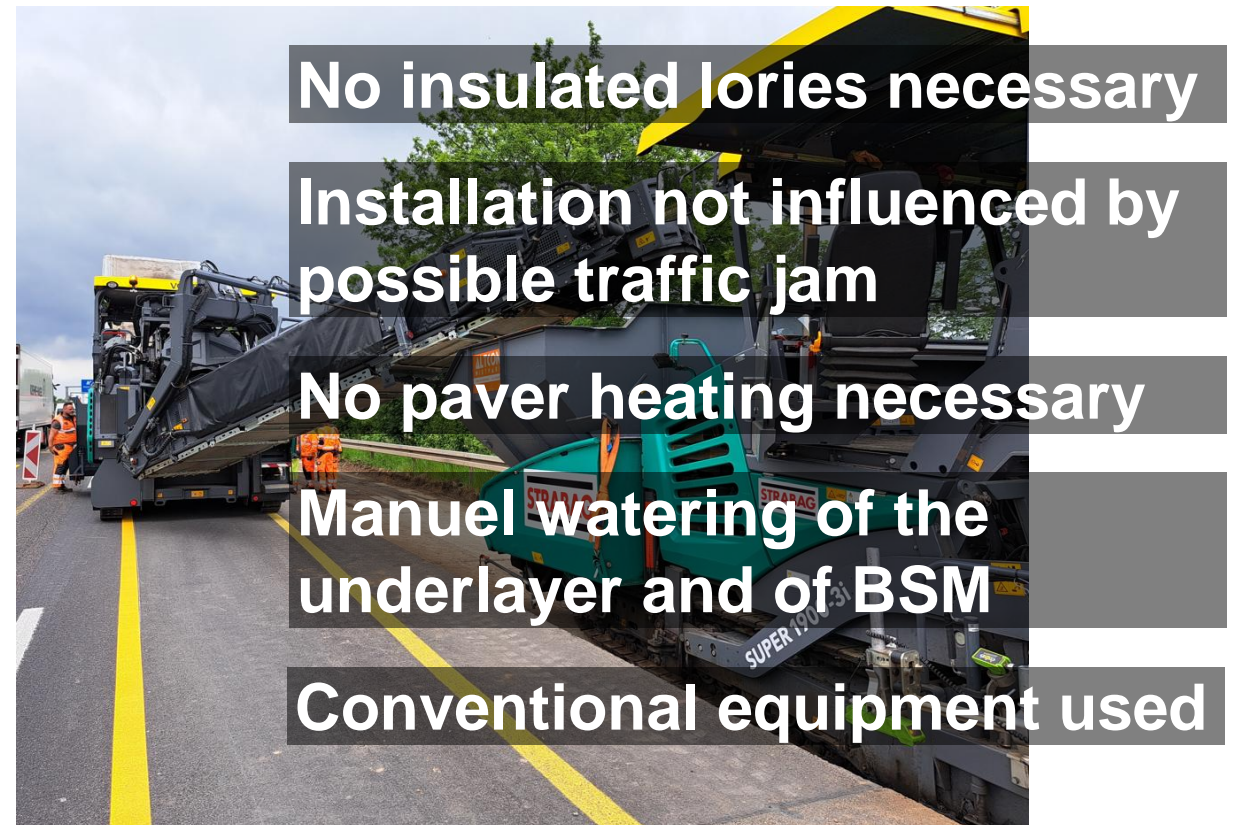
BSM Production using KMA240i

**Pre-production on 22.05.2023,
day before the installation**

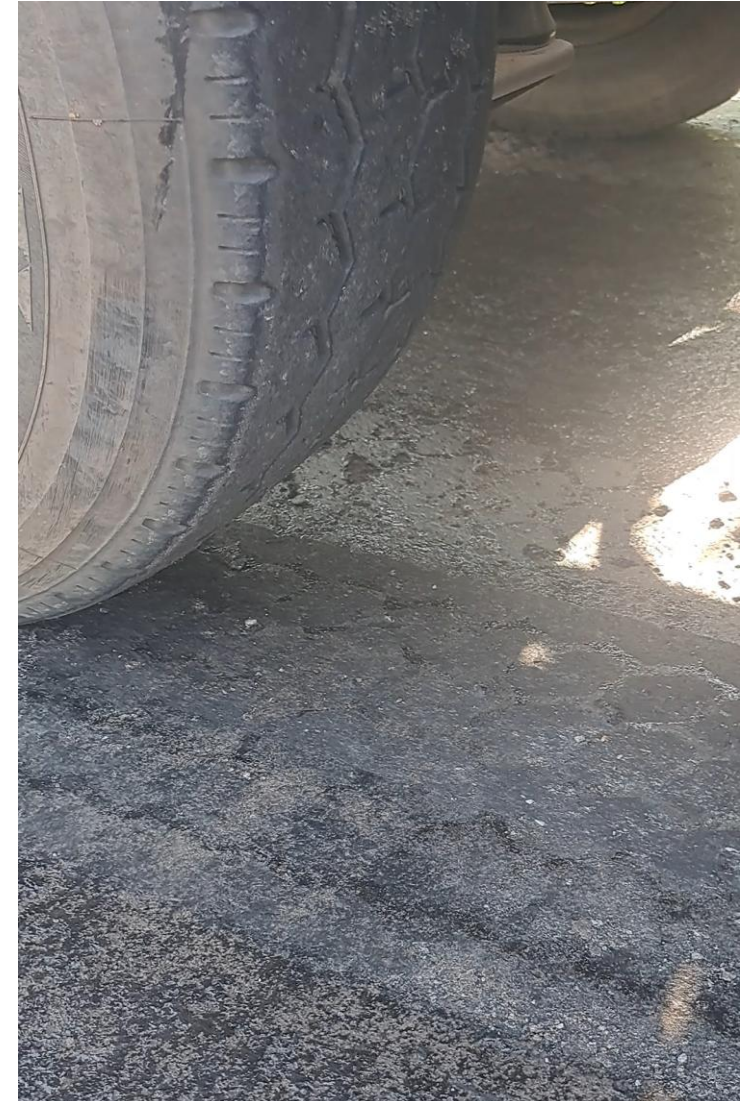
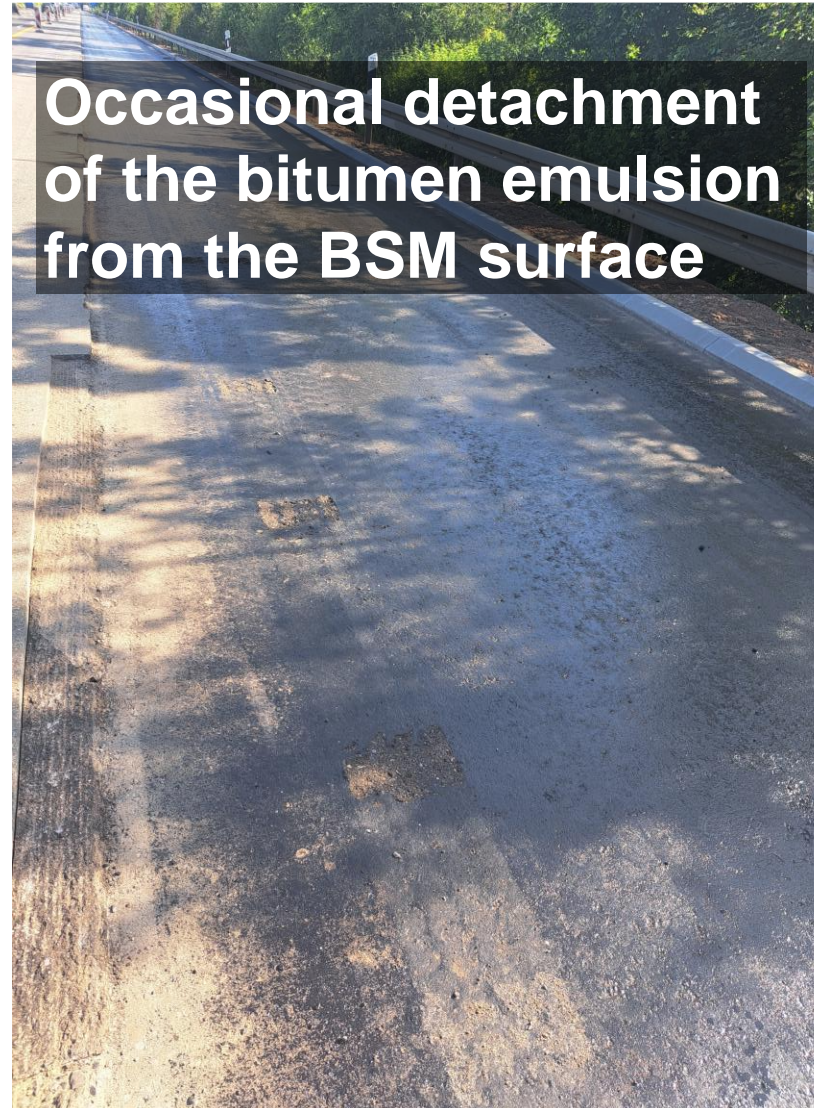
**Covering of material to prevent
drying-out**

BSM Installation

- 23.05.2023: installation of the first BSM layer (16 cm) on pre-notched stabilization
- 24.05.2023: installation of the second BSM layer (10 cm); application of the tack coat
- 25.05.2023: installation of asphalt surface layer SMA 11 S (4 cm)



BSM Installation



BSM Installation



13 t tandem roller

3 t tandem roller

9.5 t pneumatic tire roller

After 7 passes the maximum
compaction was reached

Further measurements



In 9 of 12 cores there was no layer bond between the 1st and 2nd layer of BSM

All cores layer bond between the 2nd layer of BSM and HMA

Shear force from 14.2 to 23.2 kN



Further measurements

Degree of compaction

Nr.	1st BSM layer	2nd BSM layer
1	96.3	100.8
2	96.7	101.1
5	98.6	102.8
6	98.2	101.5
7	99.3	101.7
8	99.9	102.0
11	98.4	101.1
12	98.7	100.9



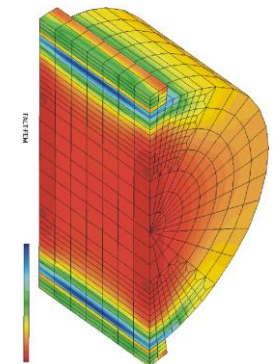
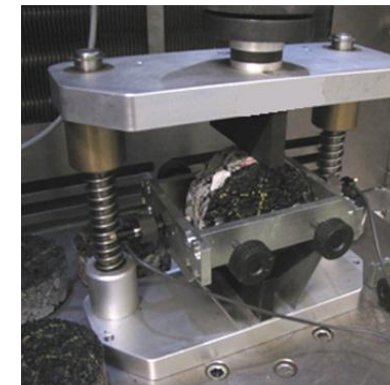
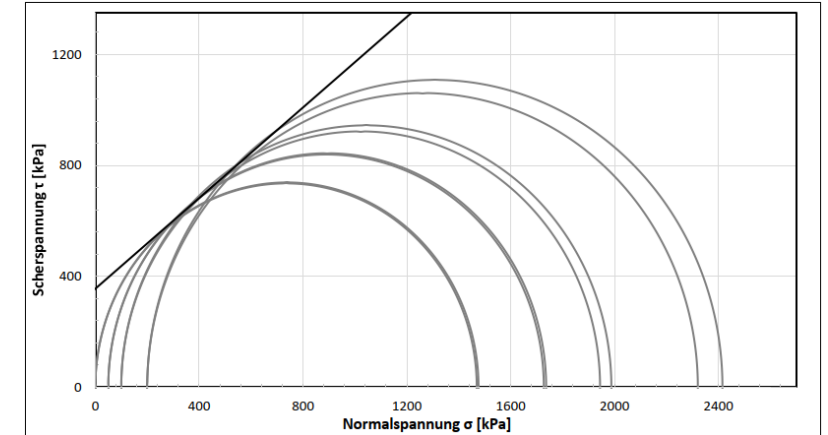
Further measurements

Indirect tensile strength

	ITS	
	ITS _{DRY}	ITS _{WET}
1st BSM layer	424 kPa	335 kPa
2nd BSM layer	337 kPa	296 kPa

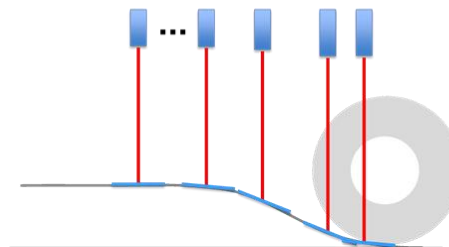
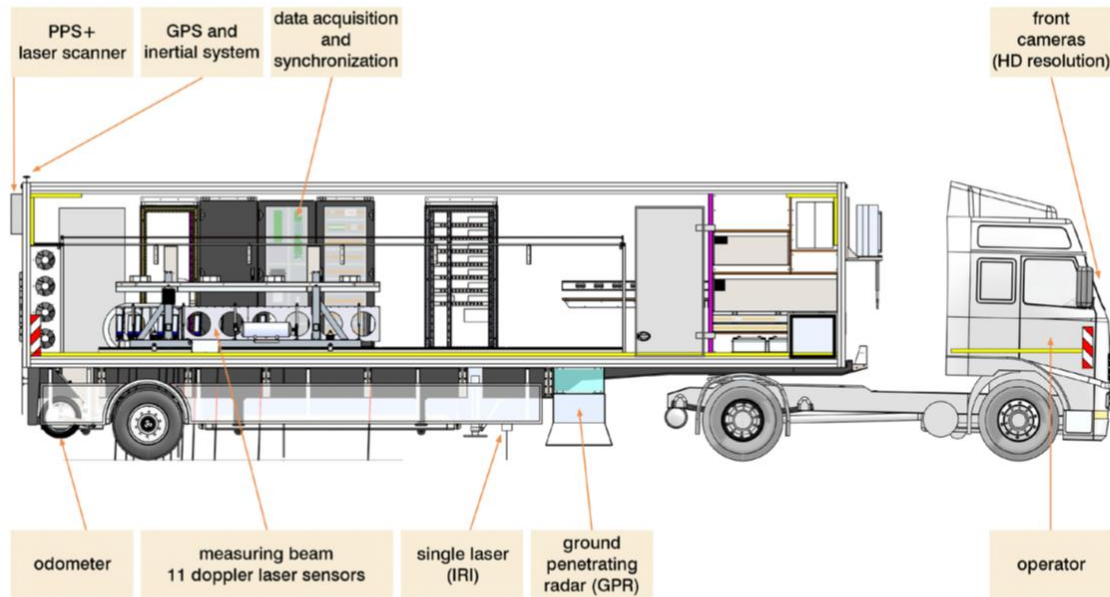
	ITS _{DRY} [kPa]	ITS _{WET} [kPa]
BSM1	> 225	> 125
BSM2	> 175	> 100

Further performance tests



Further measurements

Bearing capacity measurements - TSD



- dimensions length/width/height: 14.5 m / 2.55 m / 3.96 meter
- gross weight: 22 tons
- axle load of the semi-trailer: 10 tons (variable between 9 and 13 t)
- measuring speed: up to 80 km/h
- performance: up to 600 km/day
(60.000 measurement points at 10 m interval)

Multifunktionales Erfassungssystem zur Substanzbewertung und zum Aufbau von Straßen
Multifunctional assessment tool for the structural evaluation and the design of pavements

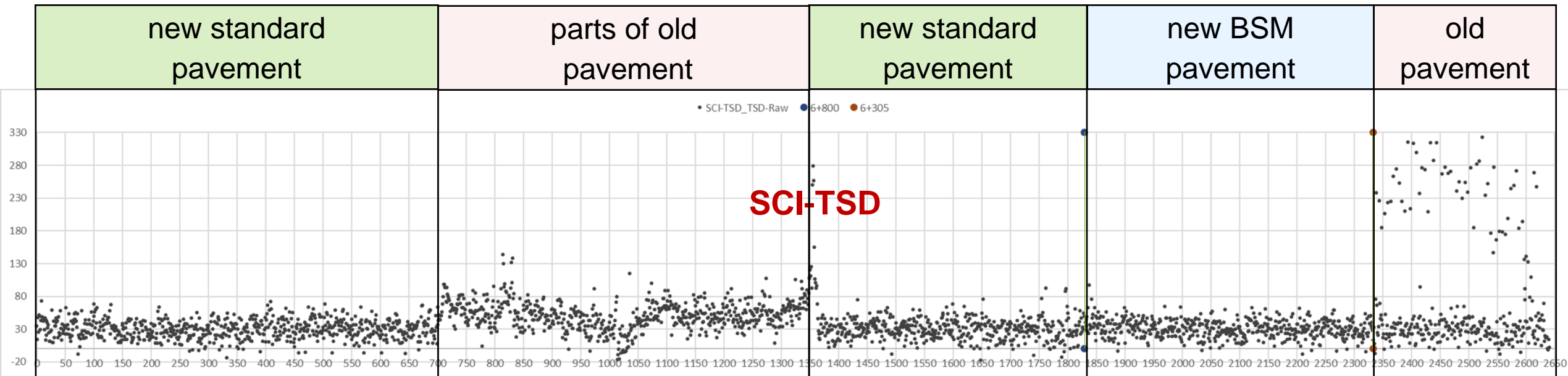
MESAS collects structural and surface condition data at traffic speed. Unique in Europe, it is based on the bearing-capacity measurement system Traffic Speed Deflectometer (TSD).

MESAS is also a project which aims to identify structural assessment procedures, which can support the pavement management on network level.

Further measurements

Bearing capacity measurements - TSD

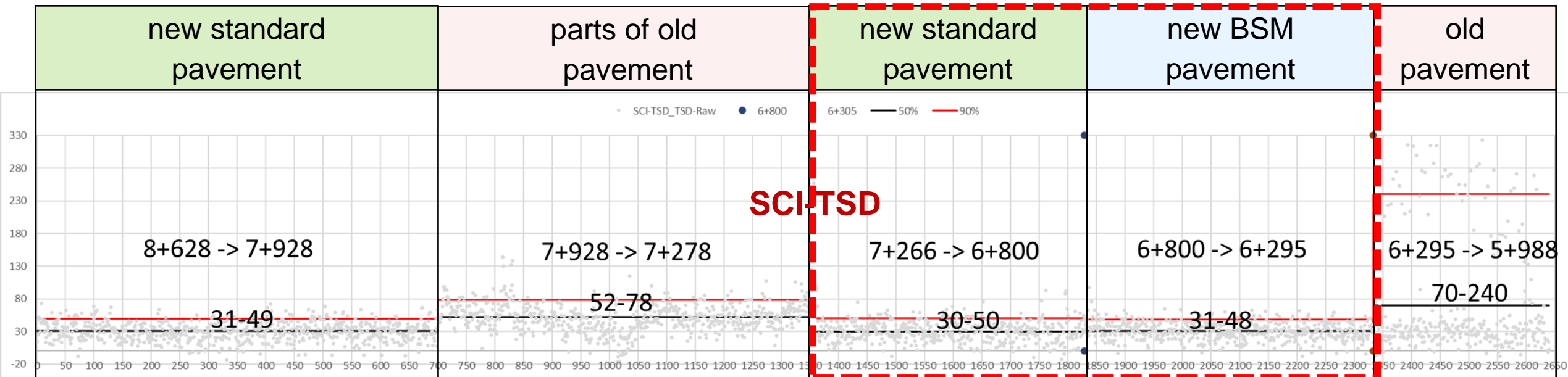
1st measurement: 04.09.2023
air temperature: ~ 19-24°C



Further measurements

Bearing capacity measurements - TSD

1st measurement: 04.09.2023
air temperature: ~ 19-24°C



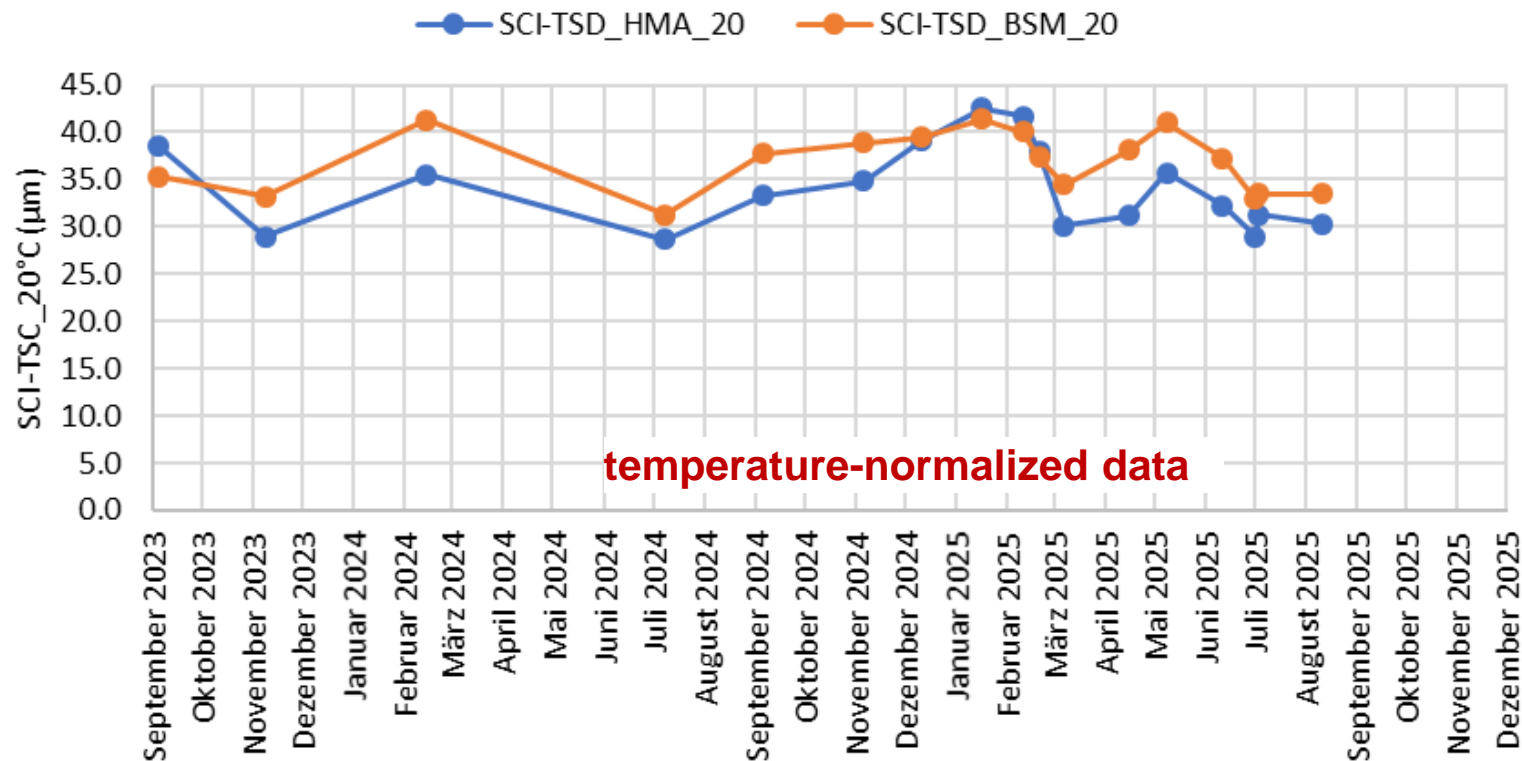
Homogeneous bearing capacity of BSM section noticeable

Bearing capacity of BSM pavement comparable to the new standard pavement

Observation of the bearing capacity of BSM pavement over the next 2 years

Further measurements

Bearing capacity measurements - TSD



**17 measurements
until now**

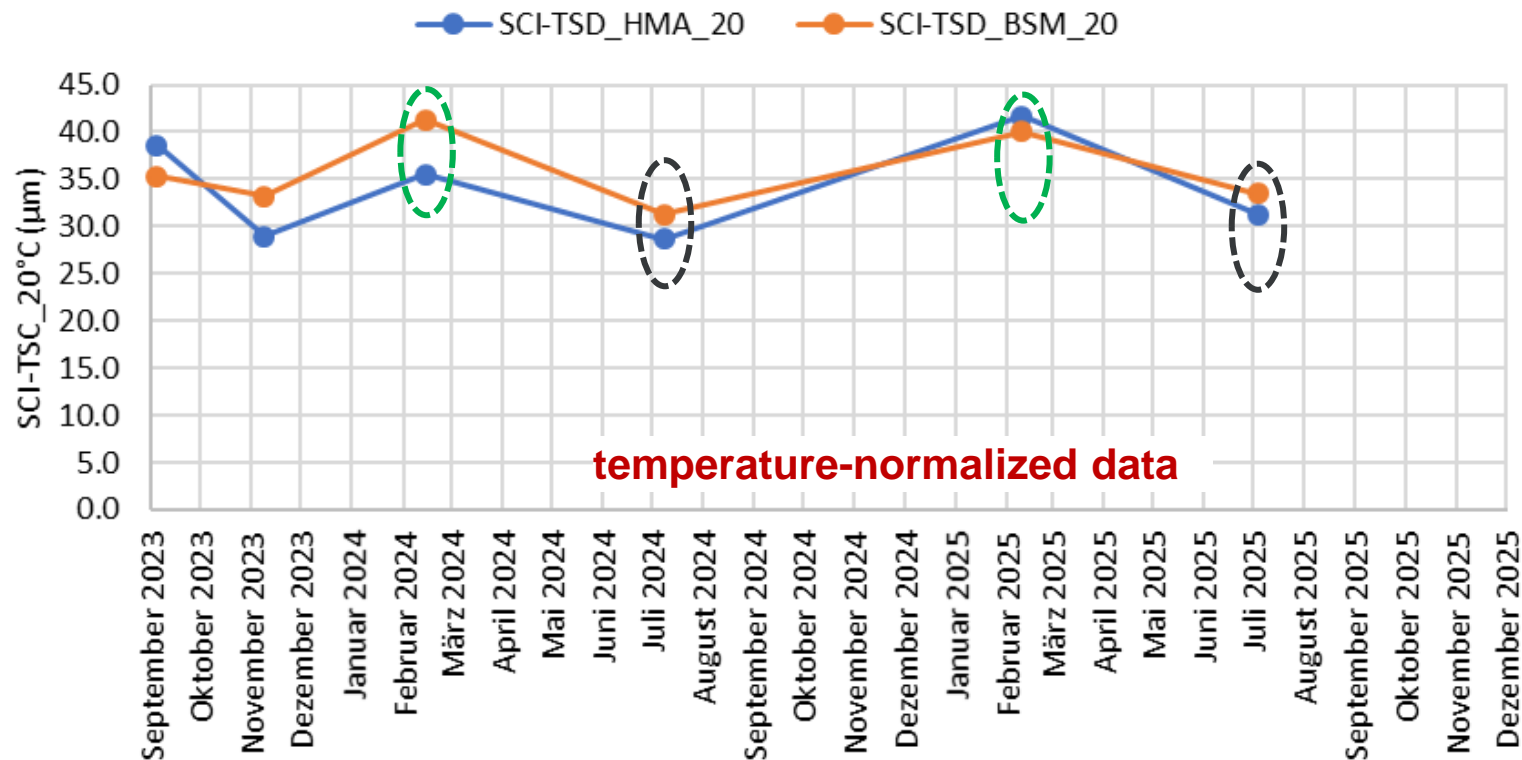


Both sections react similarly under traffic load

No significant change in structural integrity after almost two years of traffic load

Further measurements

Bearing capacity measurements - TSD



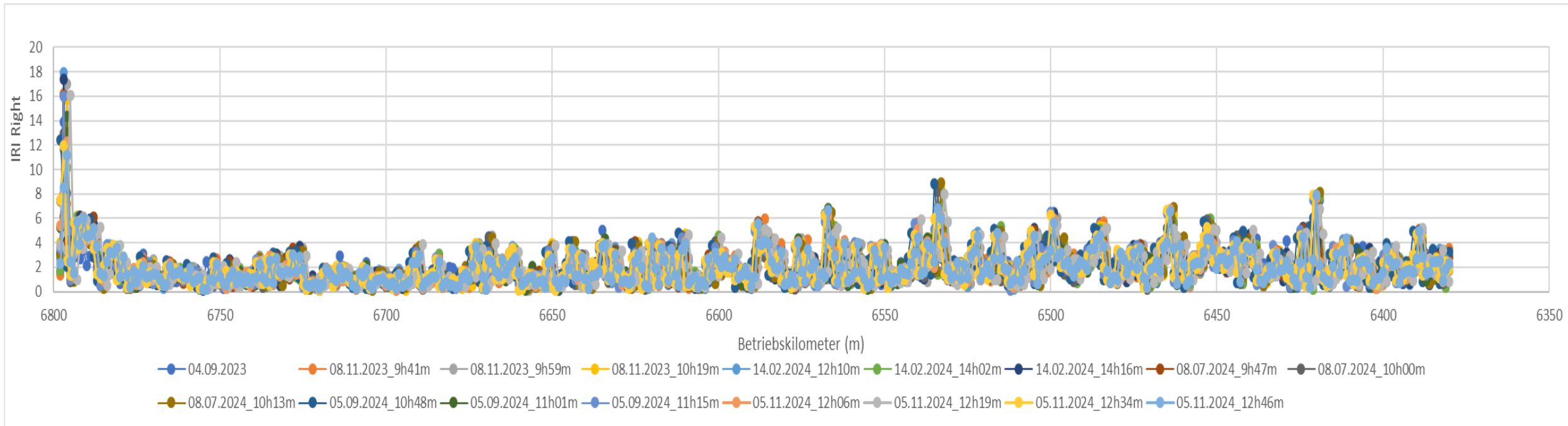
**17 measurements
until now**



Almost the same bearing capacity at the same period after one year

Further measurements

IRI Measurements



No significant change of longitudinal evenness during the time of traffic loading

Conclusions

- Very successful project on A555 using BSM instead of asphalt base and binder layer; many thanks to all partners
- After almost two years of usage there are no visible damages on the pavement surface
- The results of the non-destructive measurement methods indicate a good level of bearing capacity
- The final evaluation of the project is going to be performed after the traffic load; further laboratory tests, evaluation of the bearing capacity, longitudinal and transverse evenness, surface appearance
- This project should encourage the “asphalt people” to think out of the box and to gain better understanding for sustainable pavements
 - BSM ensures a high level of conservation of natural resources and reduction of the greenhouse gas emissions
 - BSM has significant economical benefits due to the lower new resource consumption, transport and shorter building time
- Further projects are necessary for determination of the long-term performance and for implementation in the German pavement design catalogue

Thanks for your attention

