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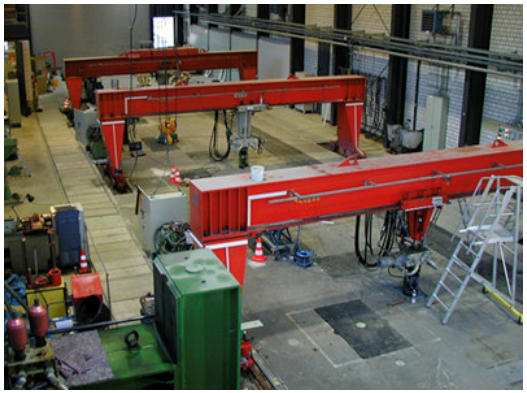
APT Monthly Web Meeting

Updates from BASt
10.04.2025

APT at BASt

- Test sites



Indoor

Full scale pavement

length: 38 m (125 ft)
width: 7.50 m (25 ft)
depth: 3 m (10 ft)

Outdoor

duraBASt test areal

6 test lanes with 100 m (320 ft) length
additional test fields/scenarios along 1 km (0.6 mi)

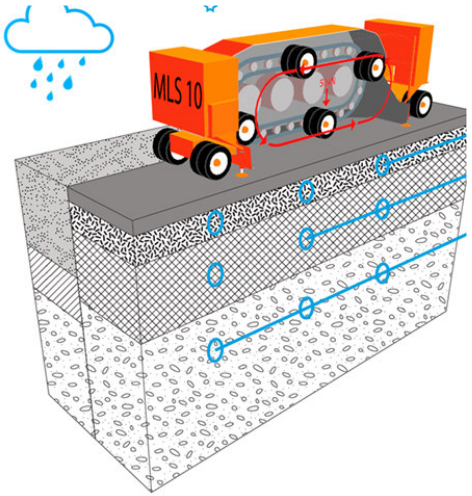
- surface monitoring approval
- bridge and tunnel research
- etc.

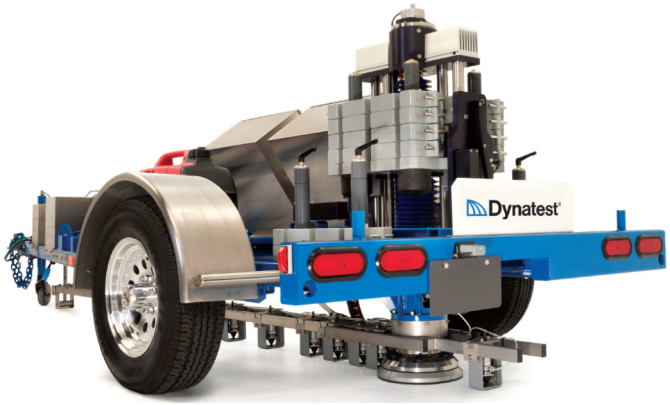
APT at BASt

- APT loading devices

Mobile Load Simulator MLS30

- 6.000 load repetitions at 50 kN wheel load per hour
- ~ 1 Mio. load repetitions per month
- Super Single tires or Dual Twin tires
- In operation since 2012





FastFWD as APT device

- 2.000 impulse loads at 50 kN per hour
- is currently being put into operation

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Current projects – very short updates

- Cold Asphalt Concrete with Bitumen Emulsion
- Foamed Bitumen and Fiber Optic Sensors

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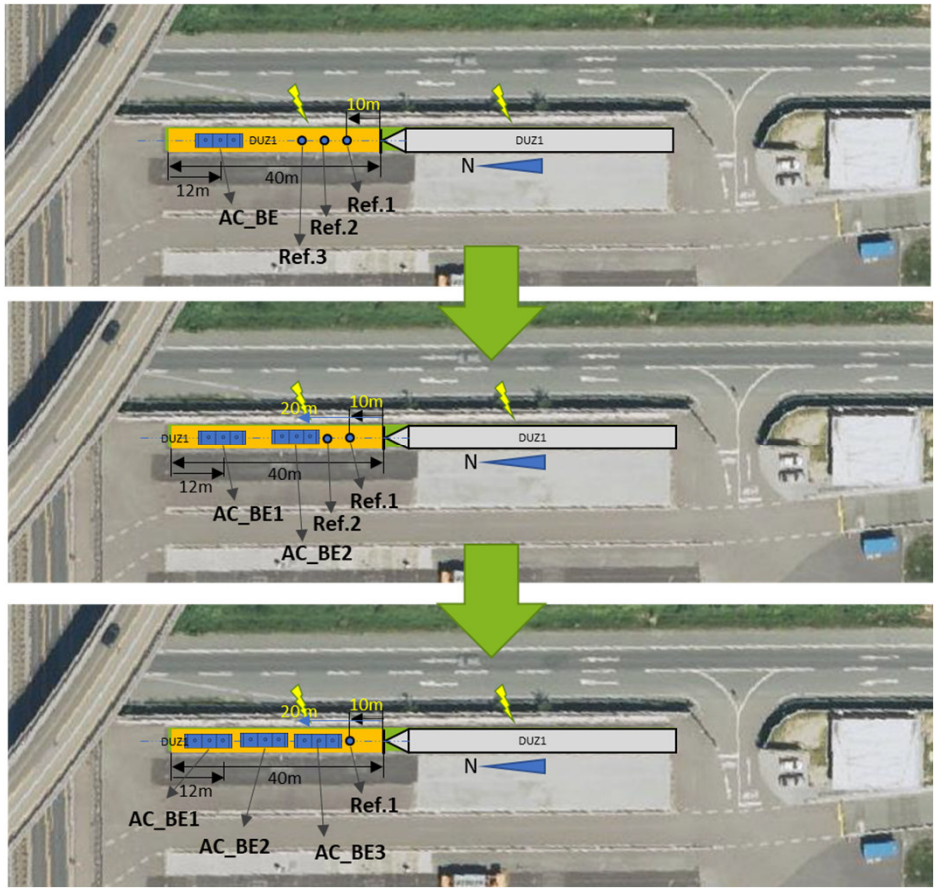
Applying Cold Asphalt Concrete with Bitumen Emulsion (AC BE) as a base layer

- Application of the EN 13108-31 for development of an asphalt concrete with bitumen emulsion as a base course
- Proof of that through an APT program at duraBASt
- 4 cm SMA 11 S over **14 cm cold recycled layer (AC-BE)**
  - **RA: 75%** + 5-22mm VA: 8% + 0-2mm VA: 2% + 15% filler
  - **4.5% Bitumen emulsion** (C60B10, 60% bitumen 70/100),
  - 1% HRB class 4 (EN 13282-1)
  - OMC = 6%
  - ITS@5° = 1.05 MPa, TSR = 74%
- Construction: August 2023
- 1st APT section: 350.000 cycles
- 2nd APT section 1.000.000 cycles
- 3rd APT section: 600.000 cycles



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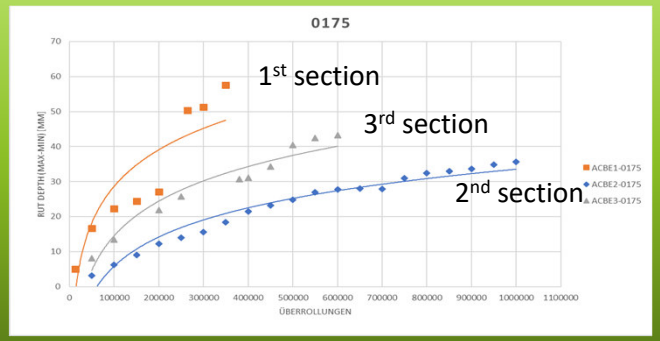
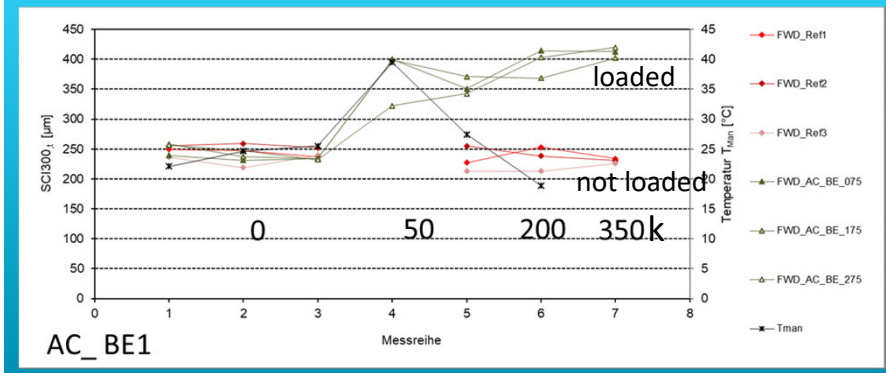
Applying Cold Asphalt Concrete with Bitumen Emulsion (AC BE) as a base layer

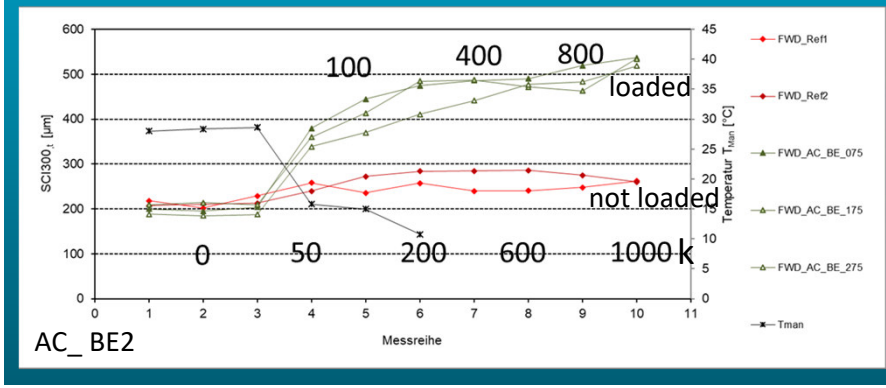
Rutting (mm)



Bearing Capacity (SCI_{300})



AC_ BE1



AC_ BE2

- High moisture in AC BE, production and construction → non-optimal mix
- The **FWD results** showed lower bearing capacity than expected (1 M.ESAL level)
- **Permanent deformation** is an issue which should be considered in mix and structural Design
- For analytical structural design, appropriate material models & failure criteria should be developed

Foamed Bitumen Surface Layer FE 07.0320/2022/EGB

46m WMA DS	49m HMA DS
4DS-SMA 8 S + **foam bitumen**	4DS-SMA
14cm AC 22 T S	14cm AC 22 T S

Quelle: https://www.wms.nrw.de/geobasis/wms_nw_dop

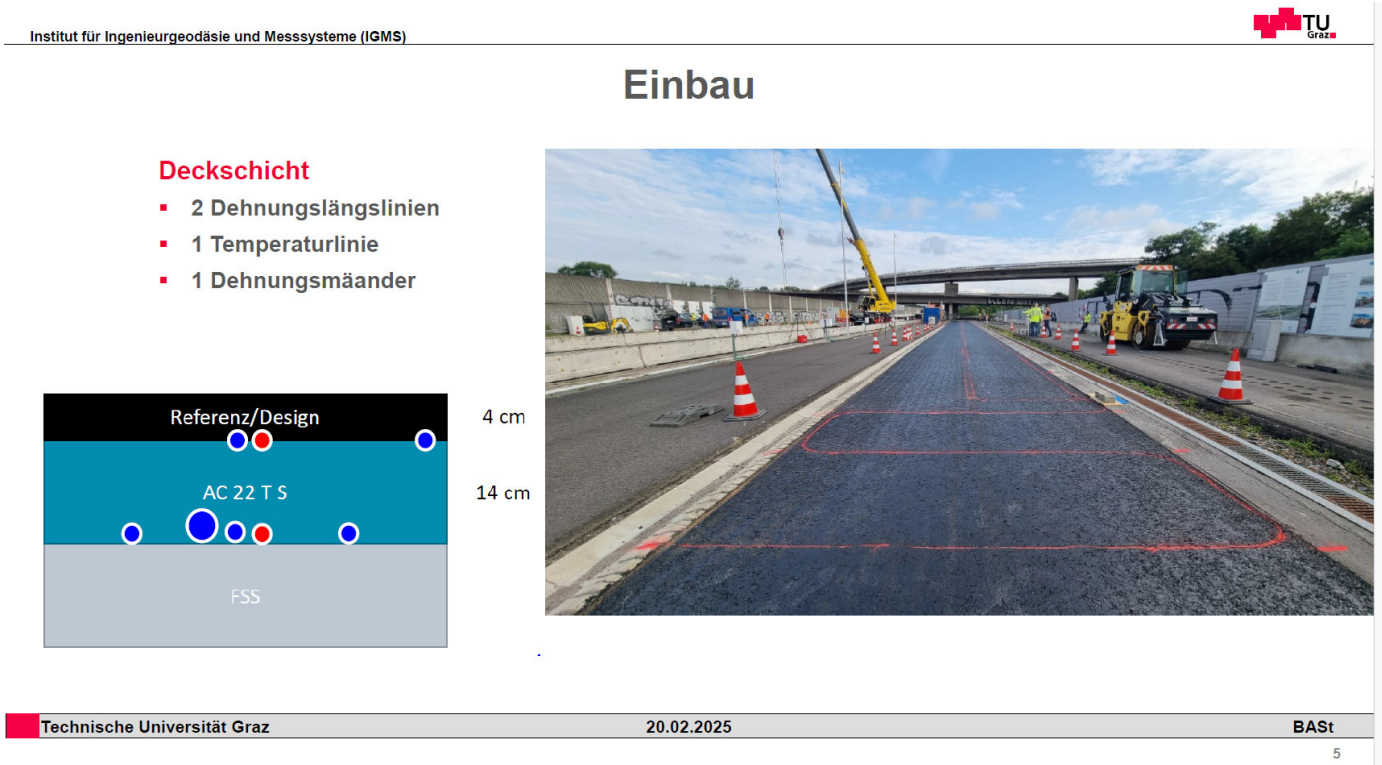
Foamed Bitumen Surface Layer FE 07.0320/2022/EGB

	50kN	75kN
AH	-	-
BH	500.000	150.000
CW	500.000	150.000
DW	-	-

Quelle: https://www.wms.nrw.de/geobasis/wms_nw_dop

Fiber optic sensors – on duraBASt

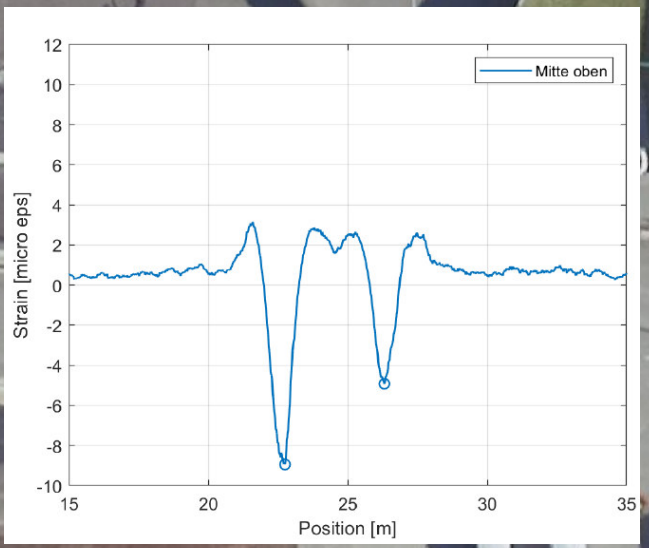
- Multiple FOS in 2 Layers with different lateral offset
- 8 cables, 80 m each
- blue= strain
- red= temperature
- Univ.-Prof. Dipl.-Ing. Dr.techn. Werner Lienhart, TU Graz



Source: Einbau von verteilter faseroptischer Sensorik und Durchführung von Versuchen am duraBASt, Prof. Lienhart, TU Graz

Fiber optic sensors – on duraBASt

LKW-Zugmaschine	Kennzeichen:		GL BA 1001	
	links	rechts	Summe	
vorne	3.050	2.800	5.850	
hinten	1.350	1.350	2.700	
		Gesamtgewicht	8.550	kg
Abstand Prisma-Hinterachse	64cm			
Vito	Kennzeichen:		GL BA 1090	
	links	rechts	Summe	
vorne	600	600	1.200	
hinten	500	525	1.025	
		Gesamtgewicht	2.225	kg
Abstand Prisma-Hinterachse	64cm			



Source: Einbau von verteilter faseroptischer Sensorik und Durchführung von Versuchen am duraBASt, Prof. Lienhart, TU Graz

Quelle: https://www.wms.nrw.de/geobasis/wms_nw_dop

Fiber-optic sensor – on duraBASt

Institut für Ingenieurgeodäsie und Messsysteme (IGMS)

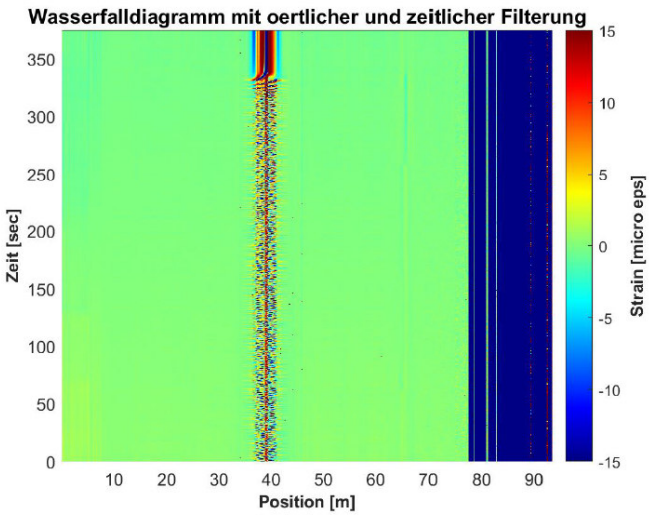
TU Graz

MLS in Betrieb

Messungen mit OFDR

- Dehnungen
- Frequenz 10 Hz
- Räumliche Auflösung 2.6 mm

Mitte oben, gefiltert



Technische Universität Graz 20.02.2025 BASt

29

Source: Einbau von verteilter faseroptischer Sensorik und Durchführung von Versuchen am duraBASt, Prof. Lienhart, TU Graz

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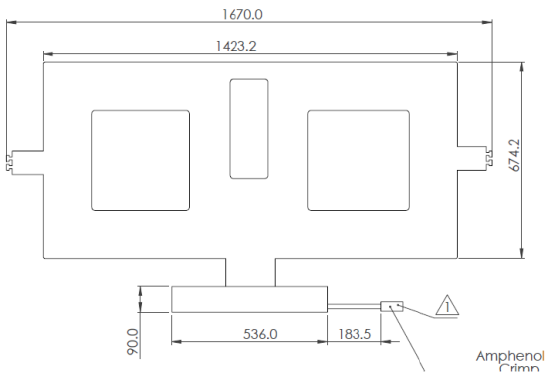
ERS – Electric Road Systems

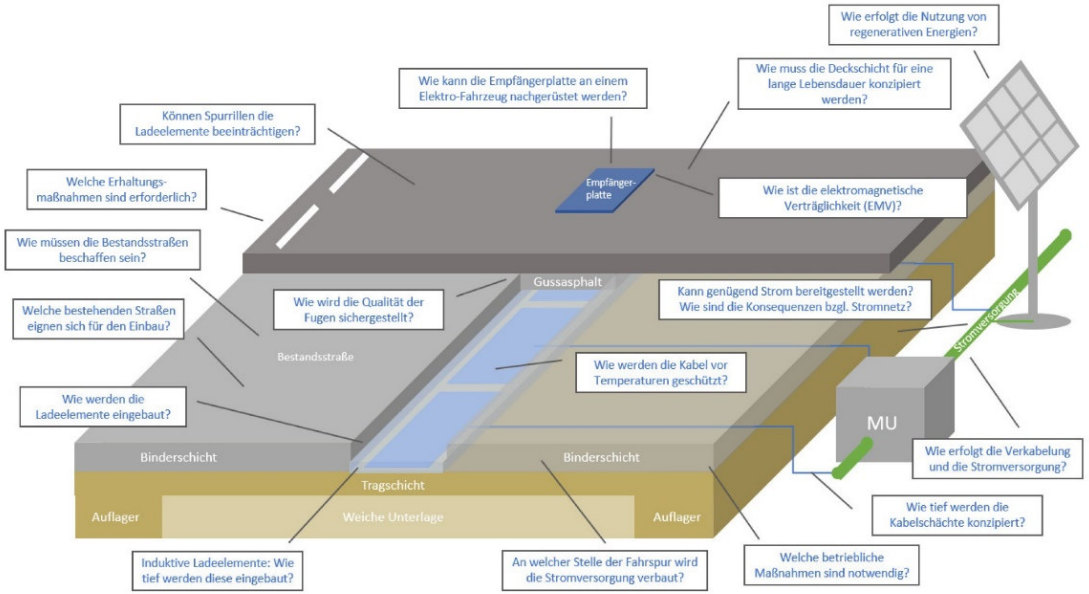
I. **ERS with Asphalt**
(short teaser)

II. **ERS with precast concrete**
(detailed presentation)

Concept „eCharge“

- Use of wireless charging coil segments by ELECTREON
- Embeddend in the binding layer depth up to 9cm
- Coil design from 2021





Source: Vorhabenbeschreibung eCharge (VIA IMC)

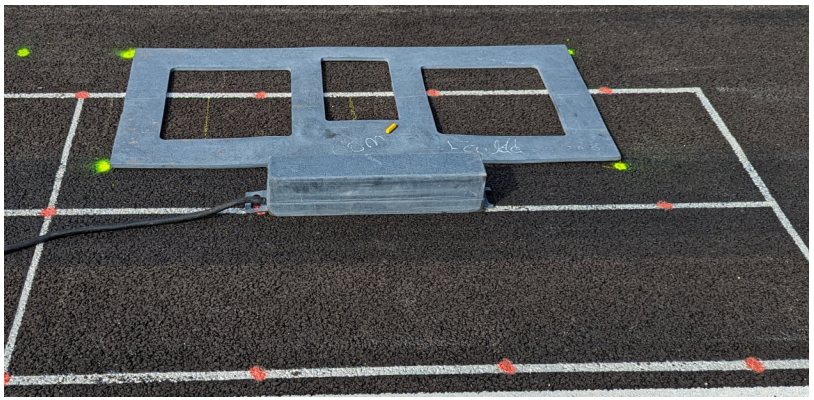
Construction on duraBASt

Testing – power transfer

- Converted VW eCrafter
- Secondary coil under vehicle underbody, height adjustable
- Integration into the high-voltage traction network distribution
- Test speed up to 60 km/h with different lateral offsets

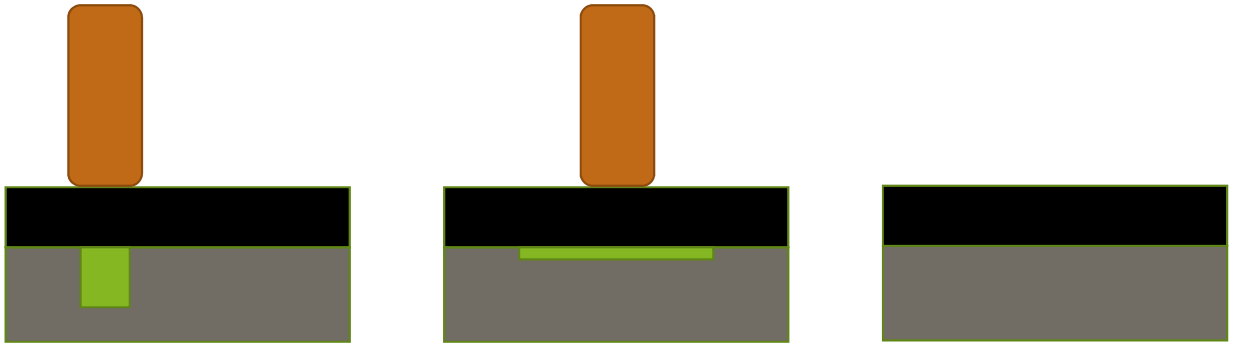
Testing – pavement properties

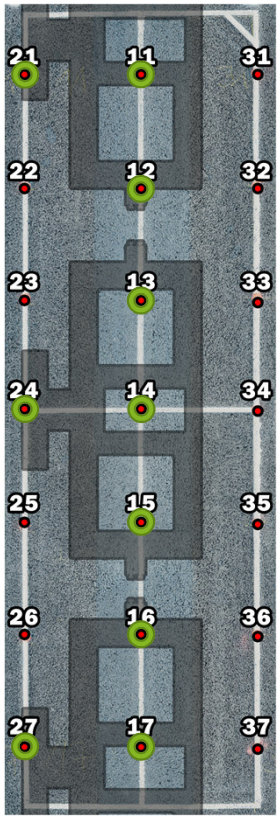
- Accelerated loading of the pavement (by use of MLS 30)
  - Loading on top of the coil and on top of the capacitor
  - About 300‘000 loading cycles (5-to wheel load – eq. 10-to axle load)
- Repeated tests with FWD and Profilometer



Testing – pavement properties – FWD results

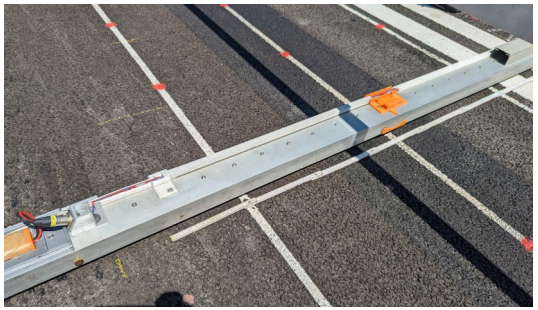
- Minor differences in deflection due to load between the composition. (load on capacitor, coil or reference)
- Indication of near-surface causes
- **Higher deflections are only caused by the load of the MLS 30 and not directly by the coils themselves.**

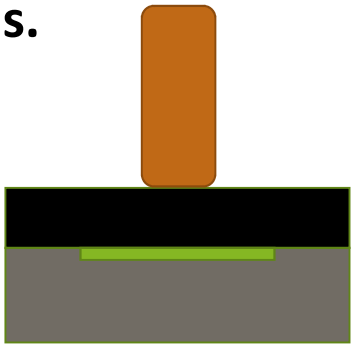


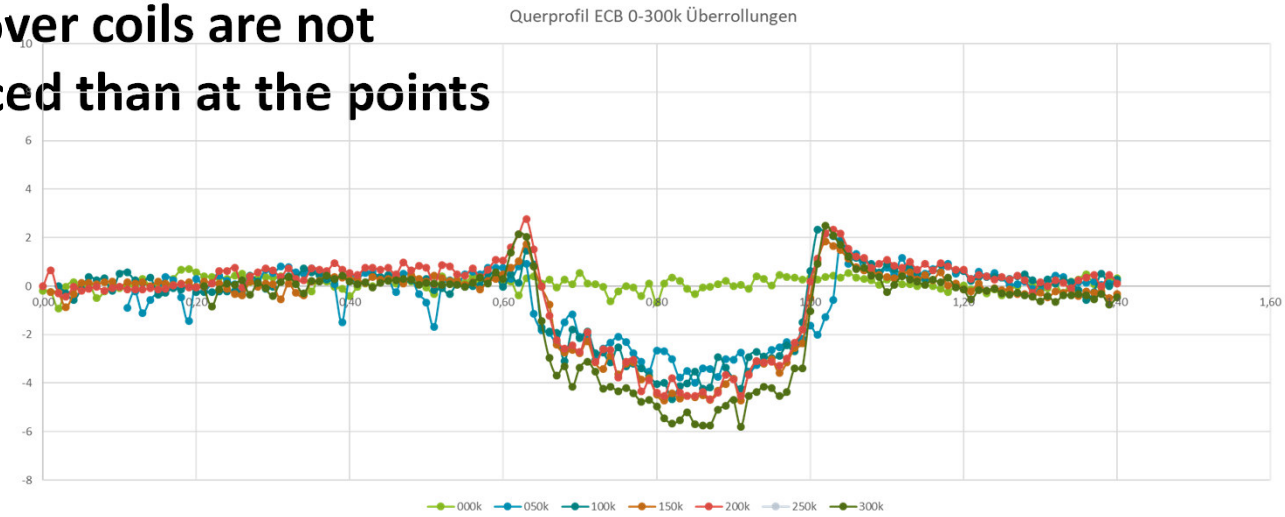


Testing – pavement properties – Profilometer

- Stationary measurements with uniform distances
- 1400mm measuring range
- Resolution approx. 0.1mm
- **Results: The deformations over coils are not significantly more pronounced than at the points without coils.**

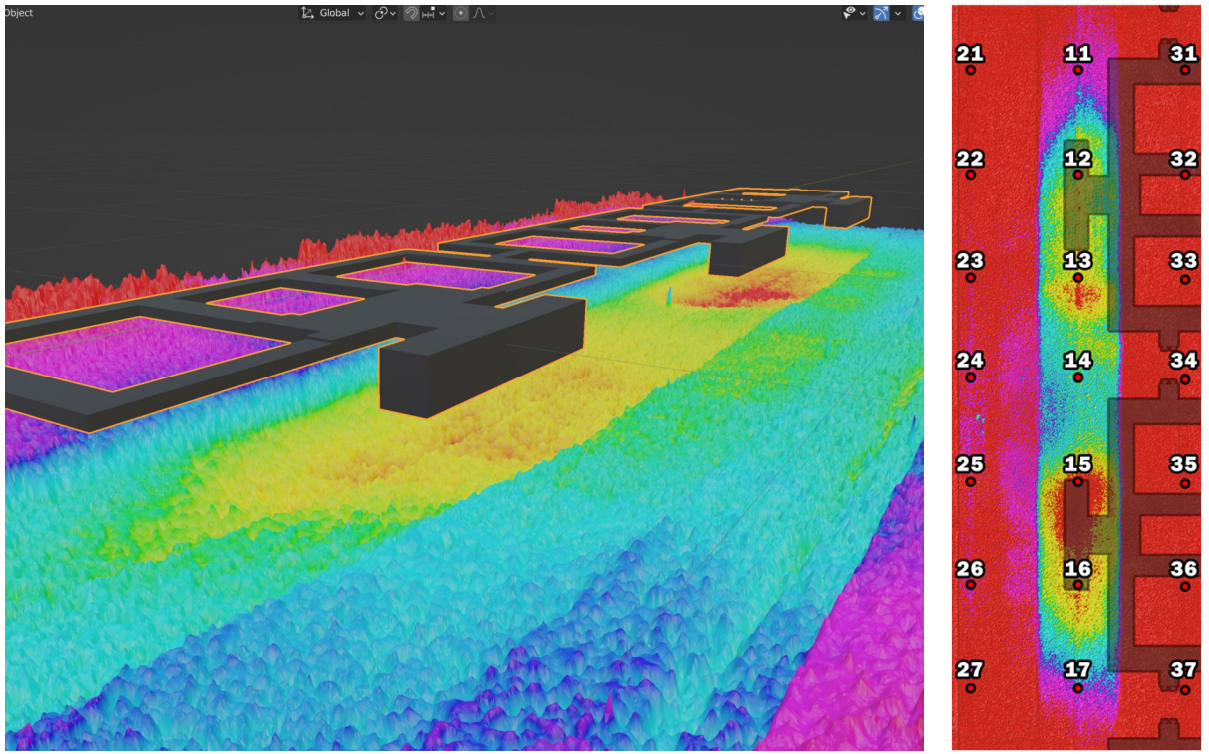






Testing – pavement properties – 3D Scan

- 3D scans based on photogrammetry
- Resolution of <1mm over an area of 3.5m x 1m
- Exaggeration of the z-axis by a factor of 20
- False color representation for better visibility
- Deformation above the capacitors clearly visible



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ERS with precast concrete

APT within the ERS R&D project “InductInfra”

10.04.2025 | Frederic Otto | BASt

Motivation for ERS

- Key challenges with BEVs
  - Limited range
  - Refueling / recharging time
  - Battery size
  - Required resources for battery production
  - Lack of sufficiently densified charging infrastructure
- ***One possible solution: ERS (Electric road systems)***

Types of ERS

Conductive

Overhead power line

source: https://ehighway.hessen.de/

Power rail

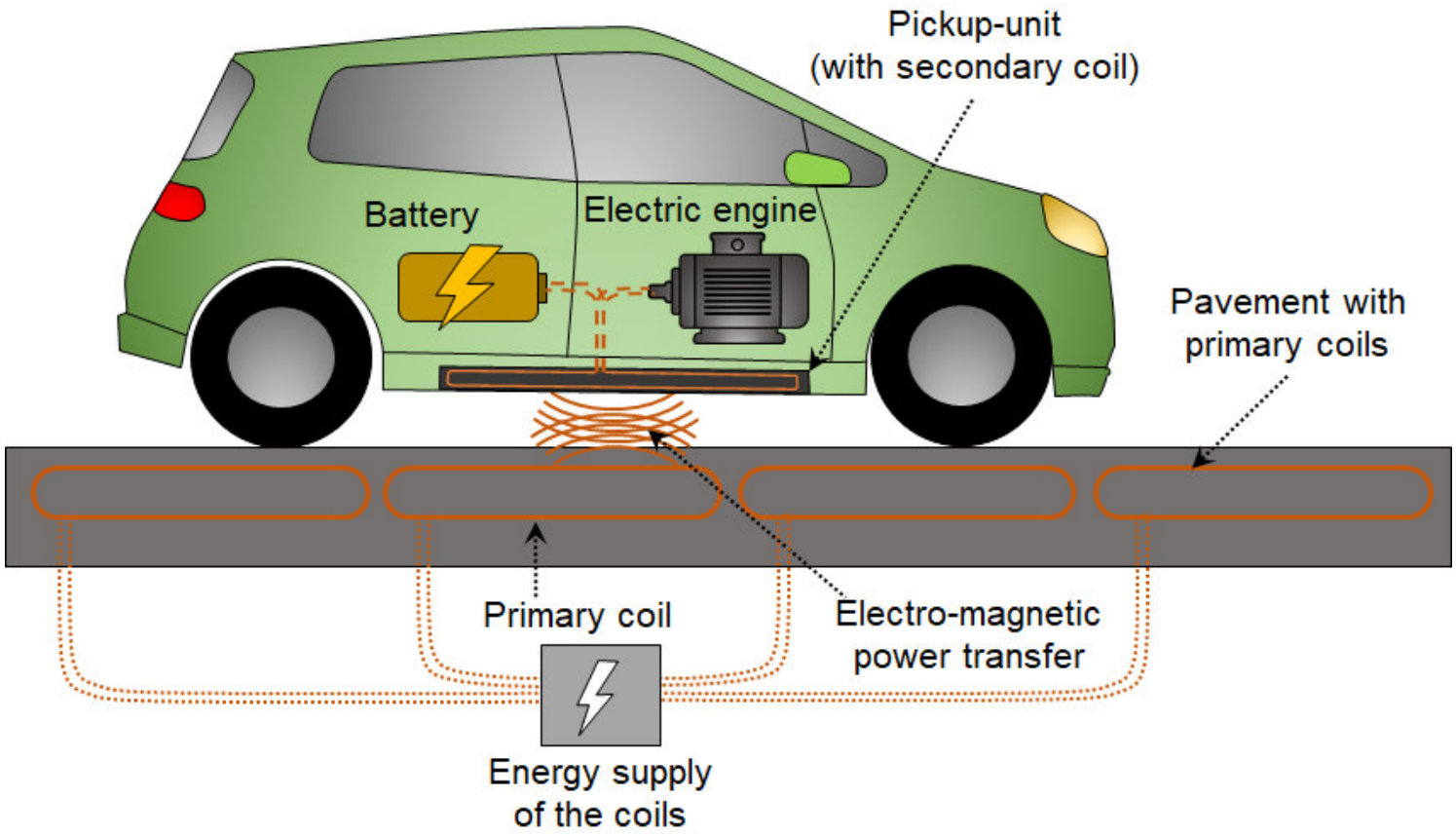
source: https://infrastructureprojects.wordpress.com/2017/11/20/alstom-presents-aps-for-road-its-innovative-electric-road-solution/

Inductive

Wireless (coils)

source: https://www.enrx.com

Inductive ERS / Wireless charging



Project „InductInfra“

- Funding: 11/2020 – 07/2024 by bast Federal Highway Research Institute on behalf of Federal Ministry for Digital and Transport
- Consortium:

ISAC Institut für Straßenwesen | IEM Institut für Elektrische Maschinen | RWTH AACHEN UNIVERSITY

WIRTGEN

ENRX

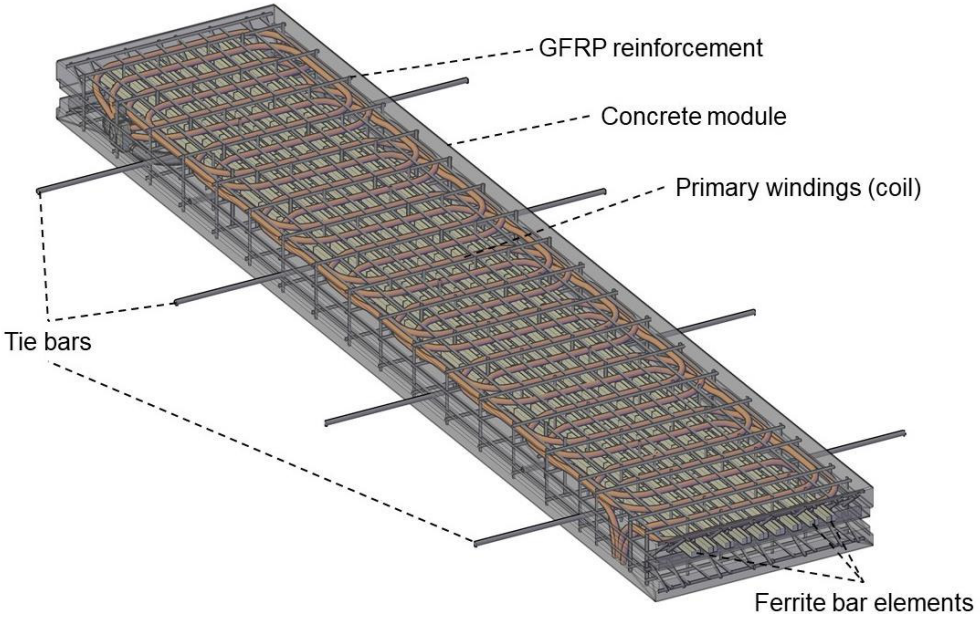
EnergieSüdwest Strom | Erdgas | Wasser | Wärme

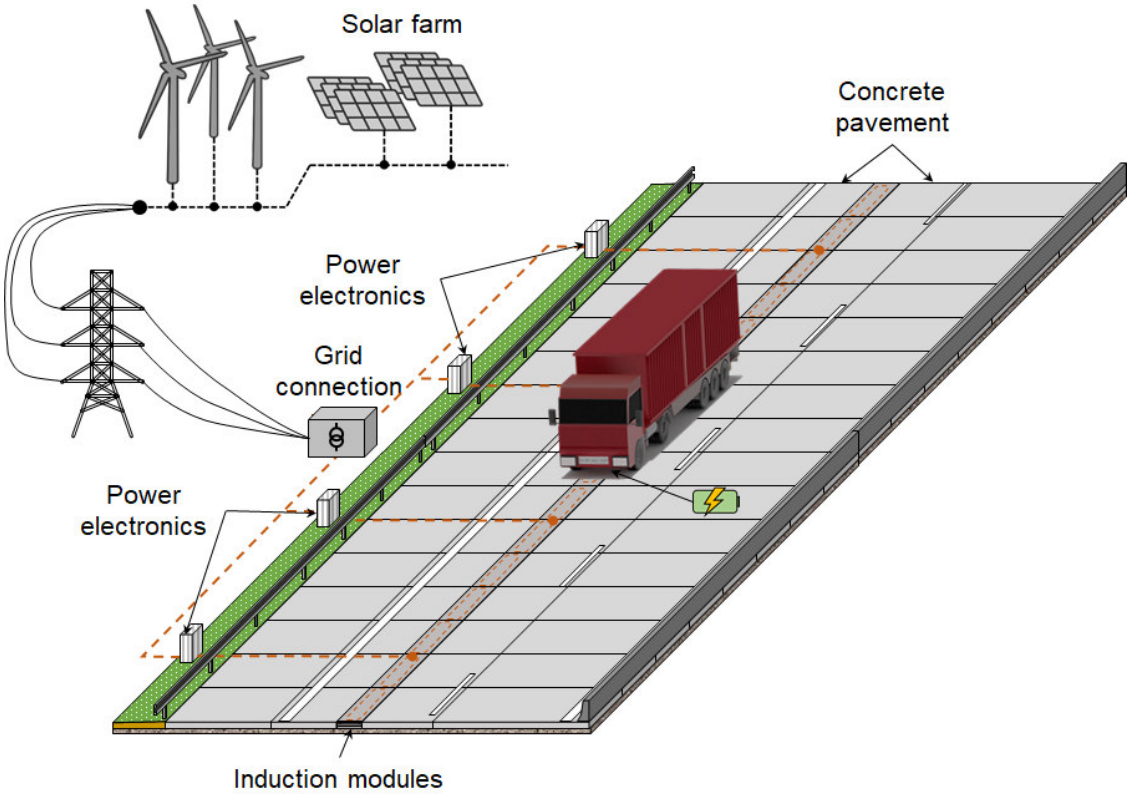
ifak

- Project goal: New construction concepts for the integration of wireless charging into the pavement structure

Project „InductInfra“

- Use of precast concrete modules

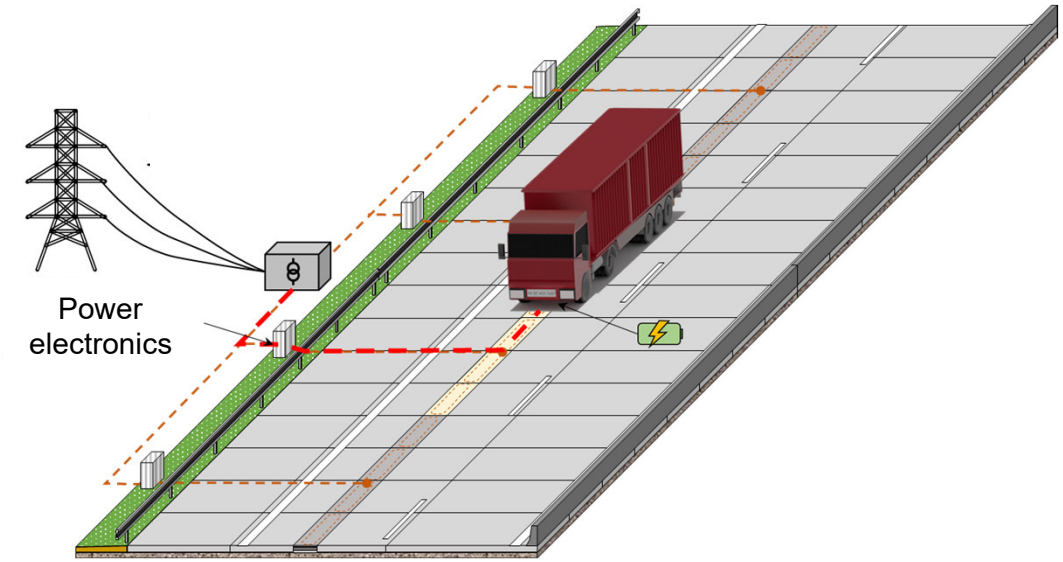




Project „InductInfra“

- Concept study and requirement analysis

Systemic requirements



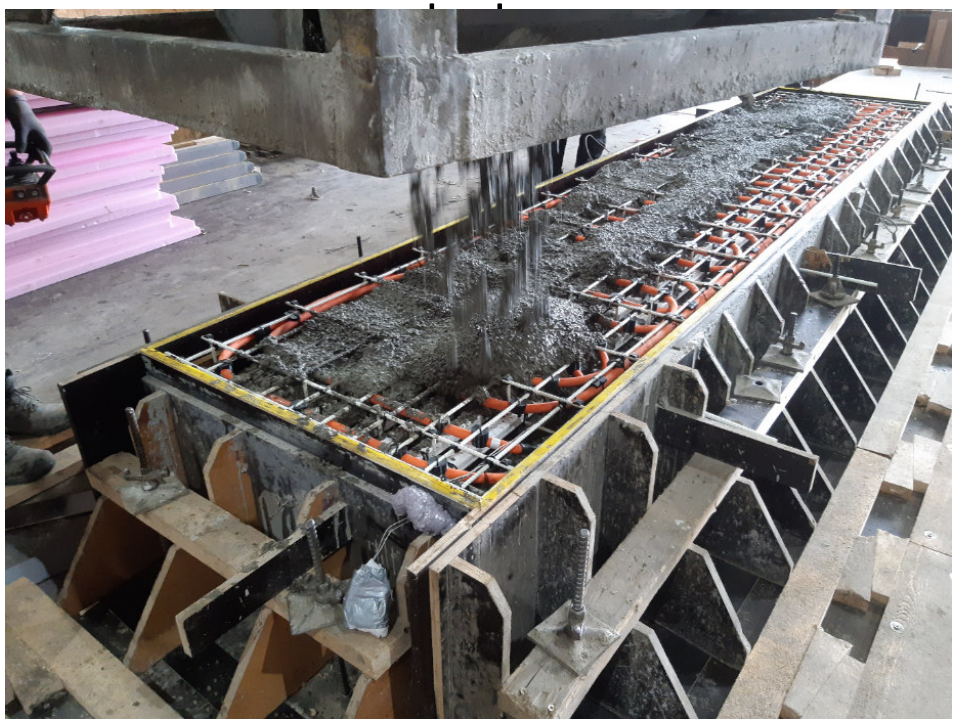
Electrotechnical requirements

Constructive requirements

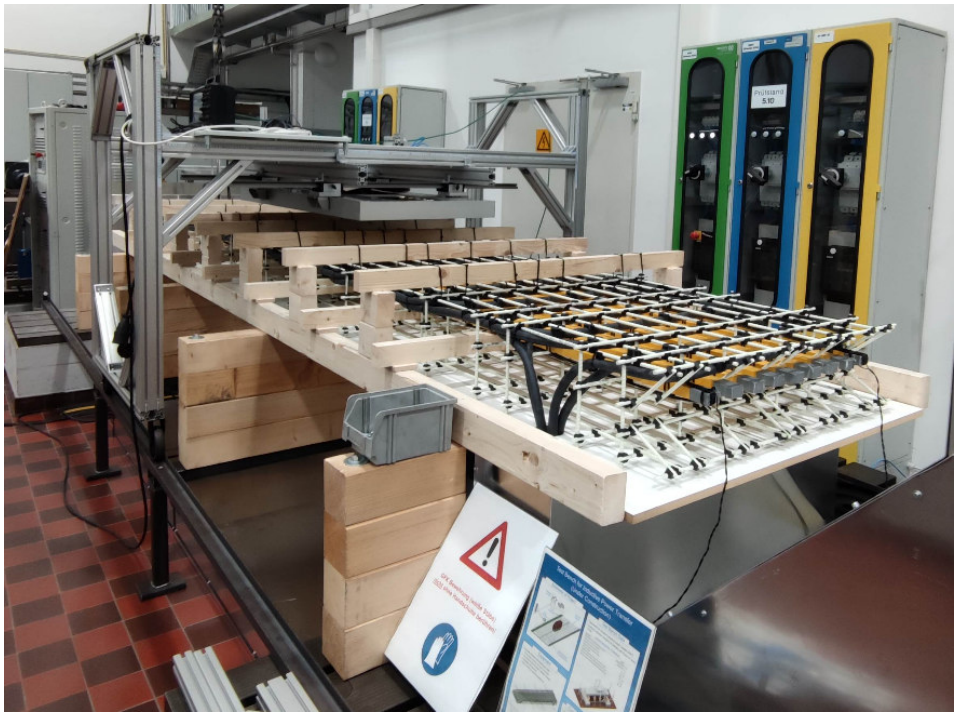
Requirements for communication and safety

Prototype testing

Mechanical

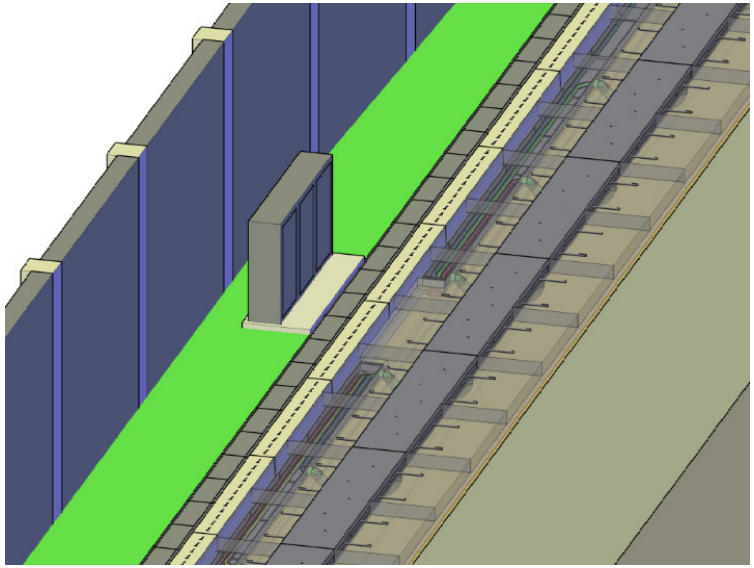


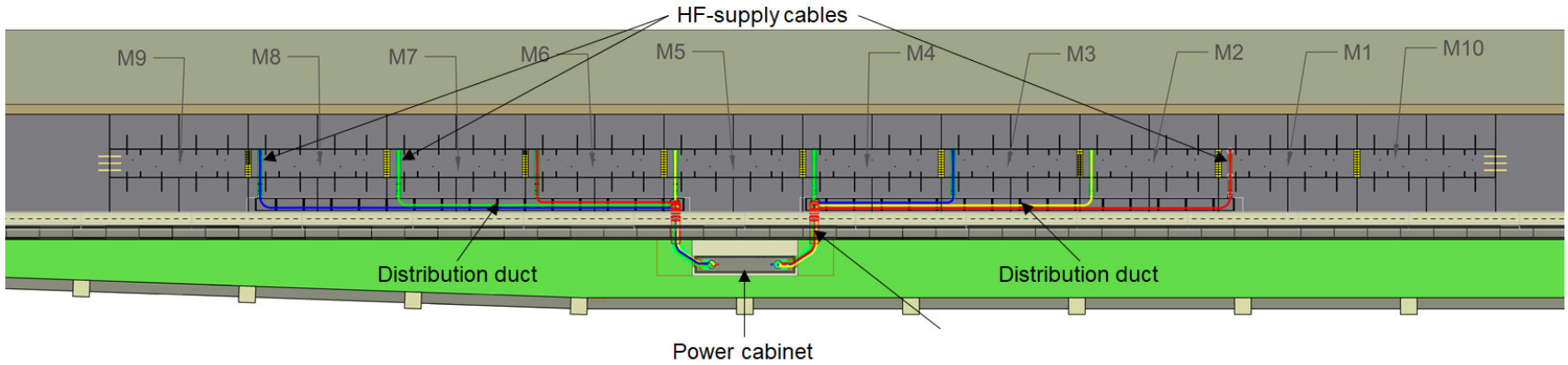
Electromagnetic tests



Development of a demonstrator

- Full scale demonstrator at duraBASt (BASt Demonstration, Investigation and Reference Area)
- 50 m section with prefab modules
- 8 functional modules





Construction of the demonstrator

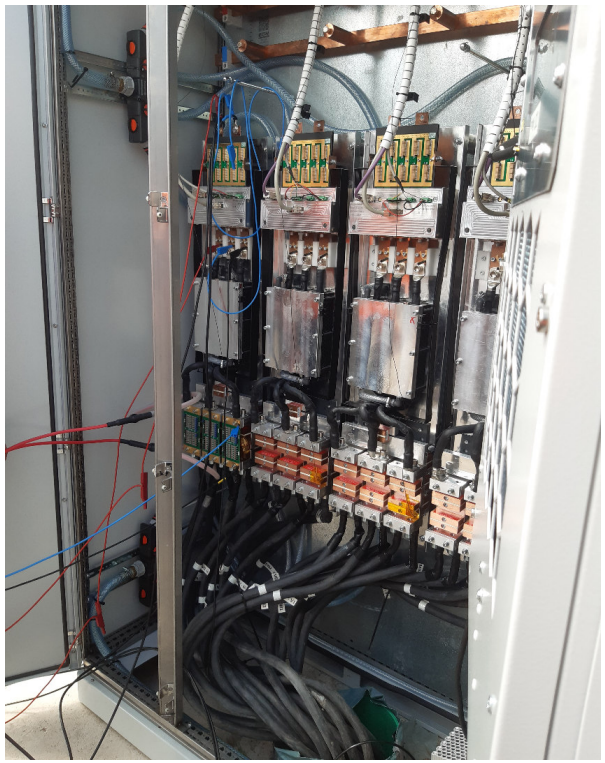
- Preparing the base layer and placing the modules

Construction of the demonstrator

- Complete the HF supply network and finalize the pavement structure

Construction of the demonstrator

- Setup of the control cabinet (power supply)



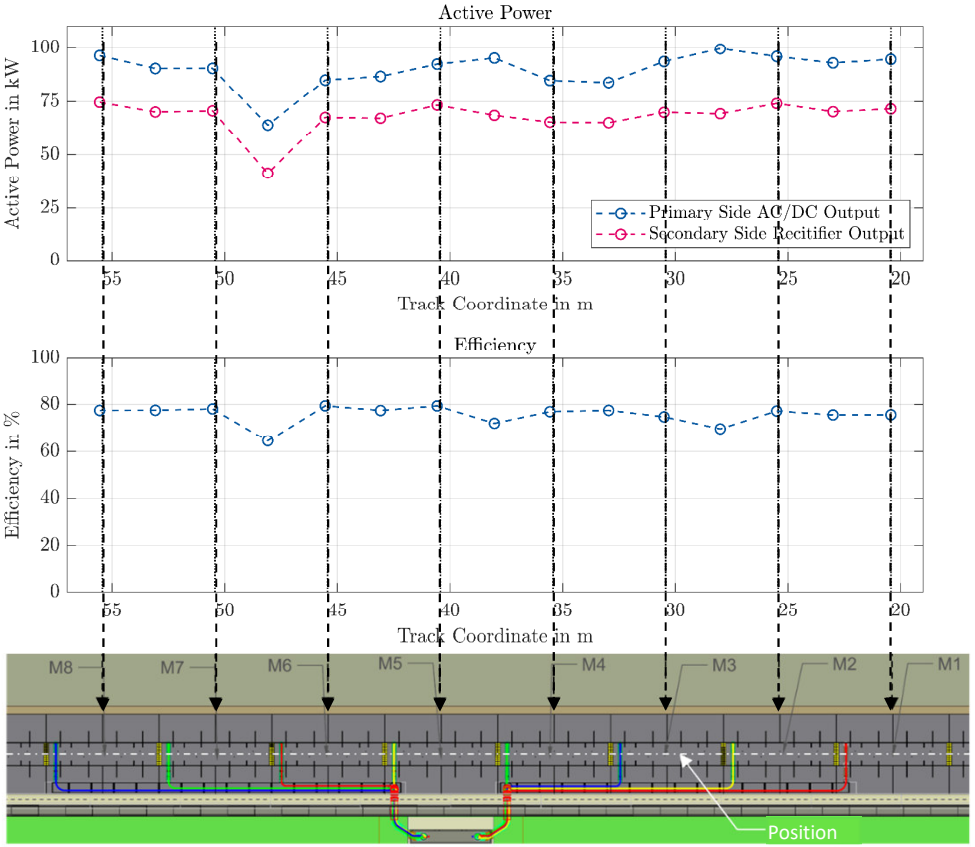
Finalized demonstrator

Testing – power transfer

- Test vehicle with trailer

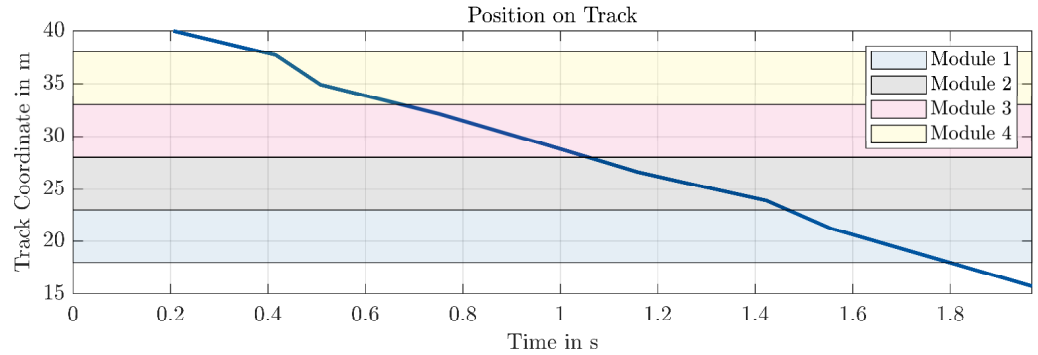
Testing – power transfer – results

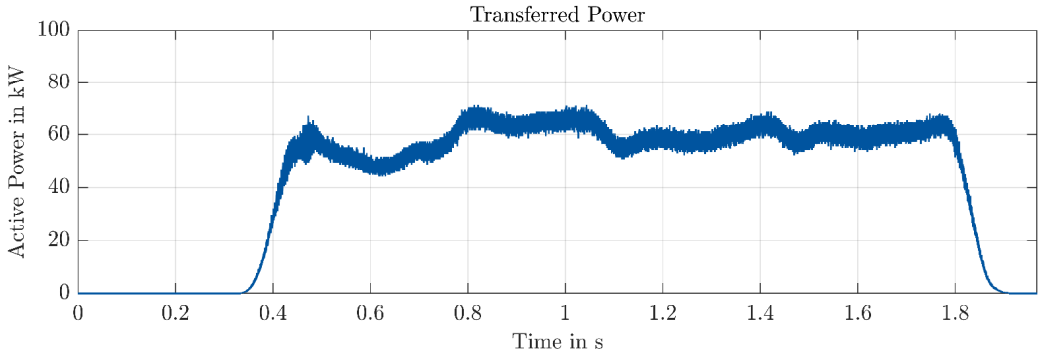
Stationary tests



Dynamic tests

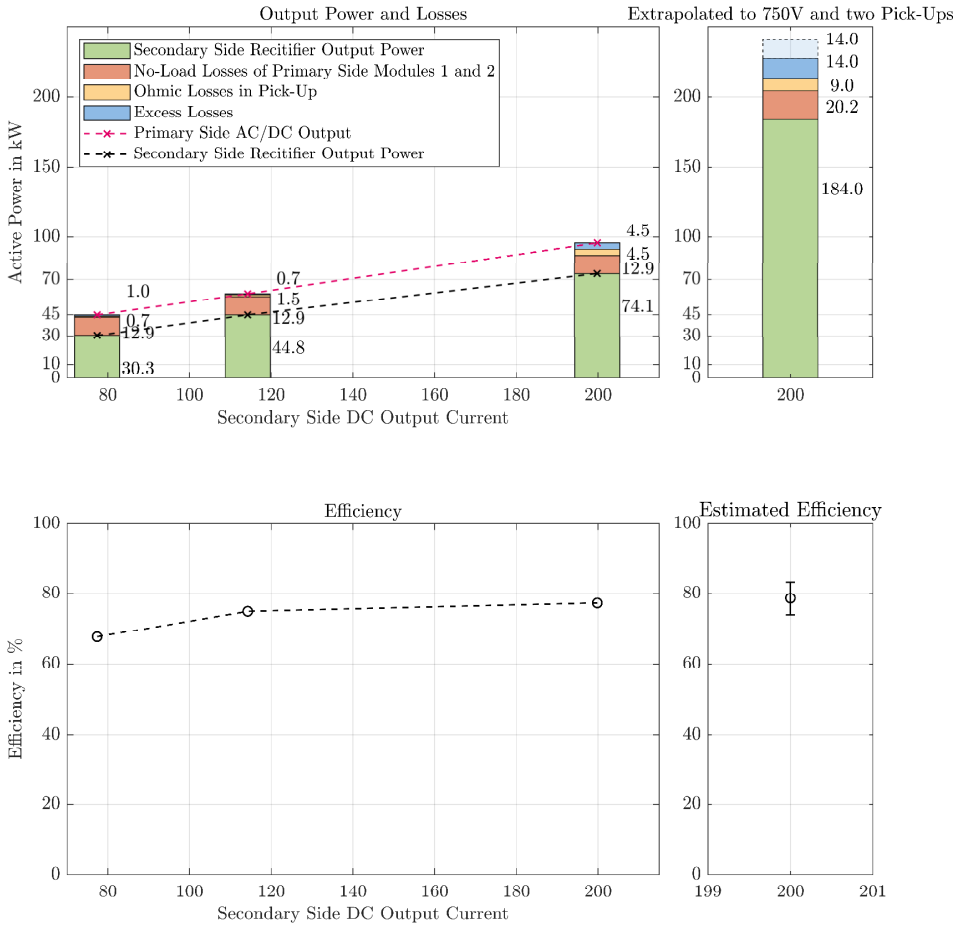
(v = 50 km/h)





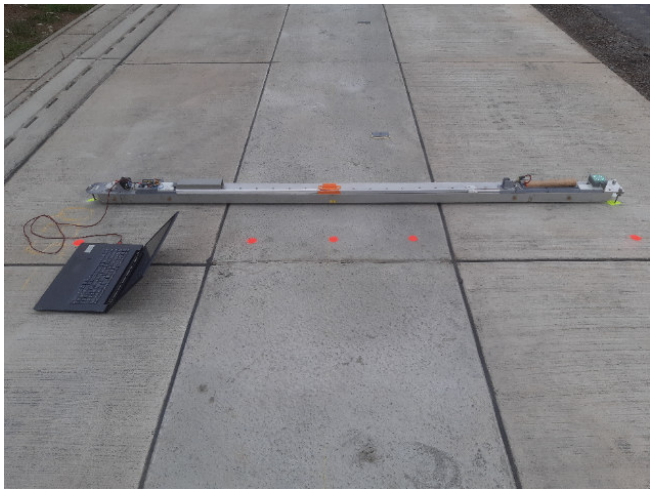
Testing – power transfer – conclusion

- Functional requirements fulfilled
- Power level within reasonable values troughout the whole test track
- Design potentials for optimization
- Estimated max. values (for two pick-up units):
  - 184 kW
  - Efficiency: 76 % - 82 %



Testing – pavement properties

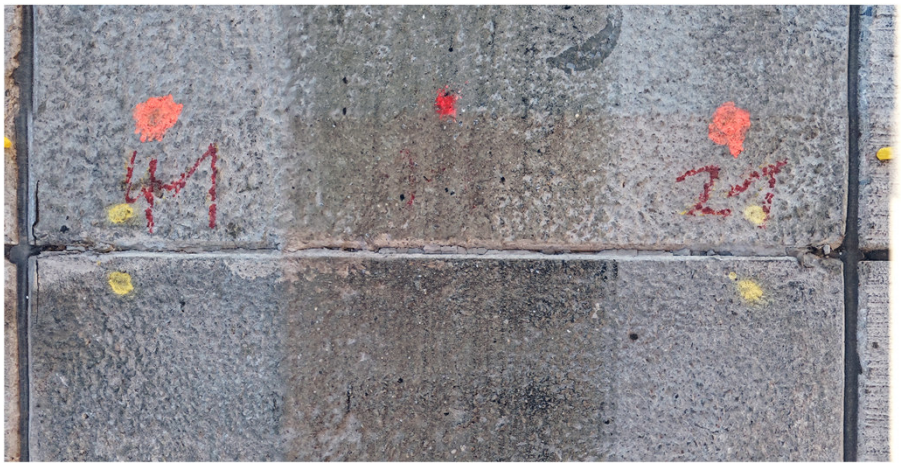
- Accelerated loading of the pavement (by use of the MLS 30)
  - Loading of the joint area
  - 500‘000 loading cycles (5-to wheel load – eq. 10-to axle load)
- Repeated tests with FWD and profilograph



Testing – pavement properties – visual results

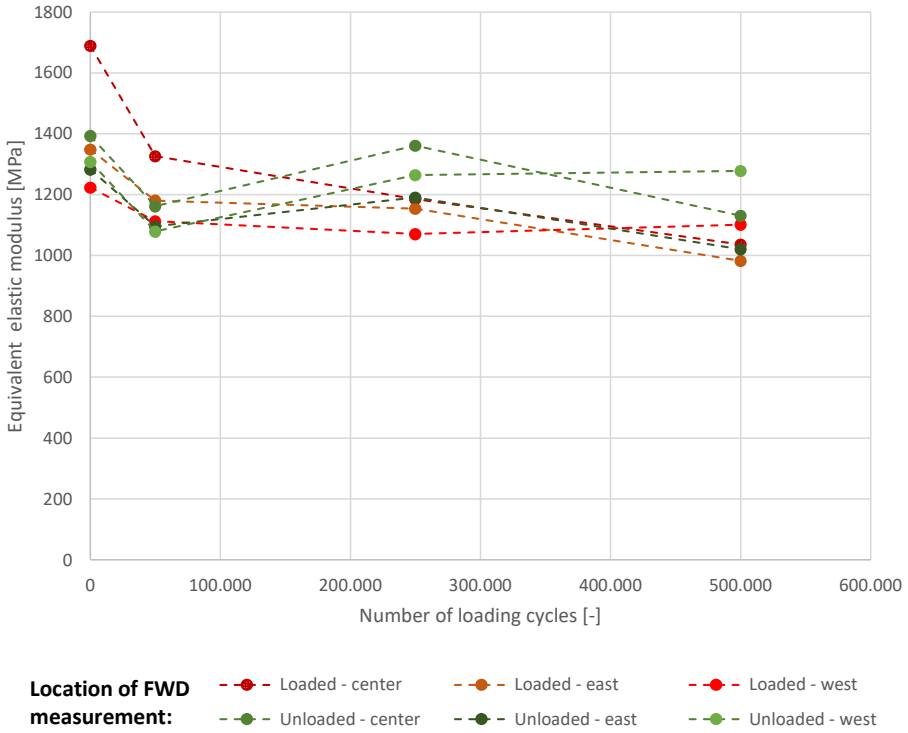
Before loading

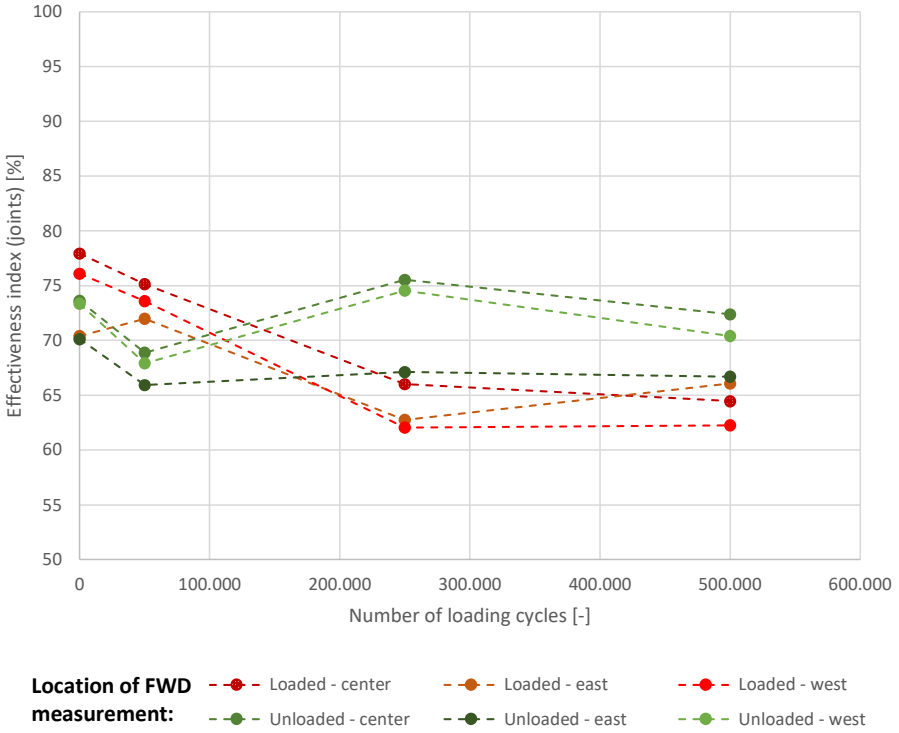
After 500 000 load cycles



Testing – pavement properties – FWD results

- Comparison of behaviour of loaded and unloaded joints

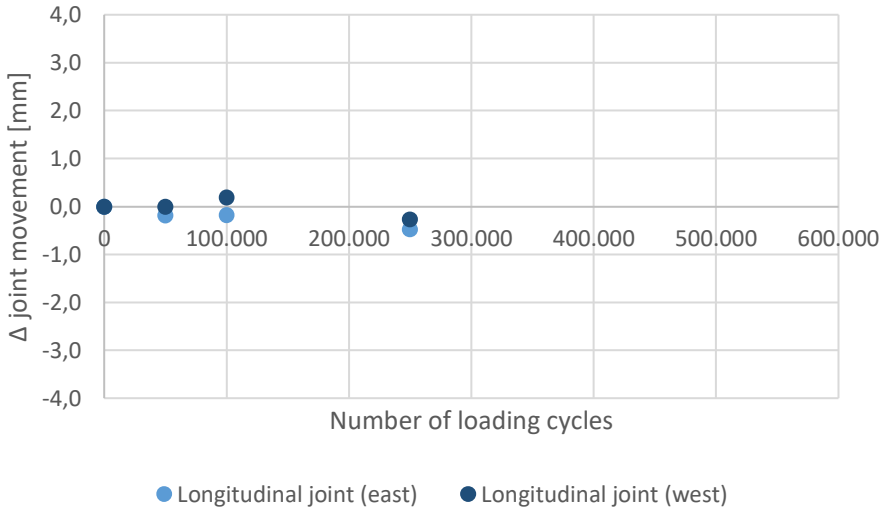




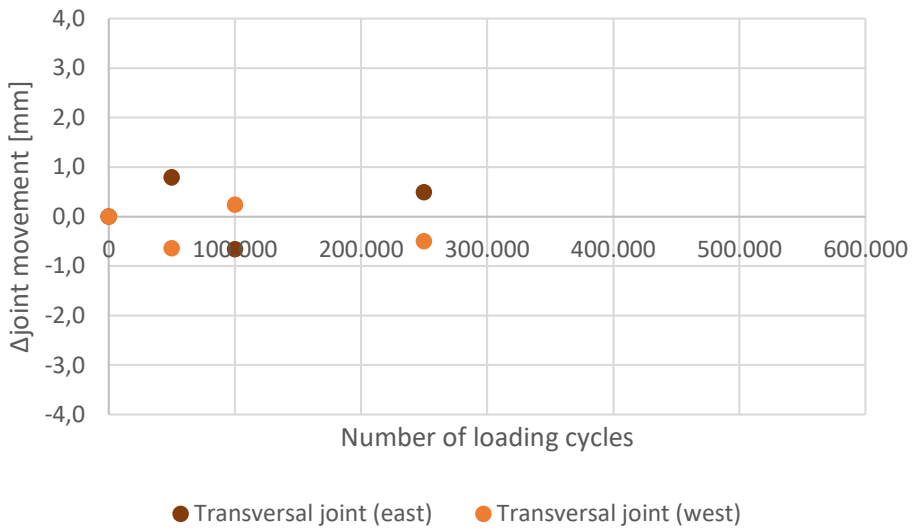
Testing – pavement properties – profilograph

- Relative movements at the joints

Transversal profile



Longitudinal profile



Testing – pavement properties – conclusion

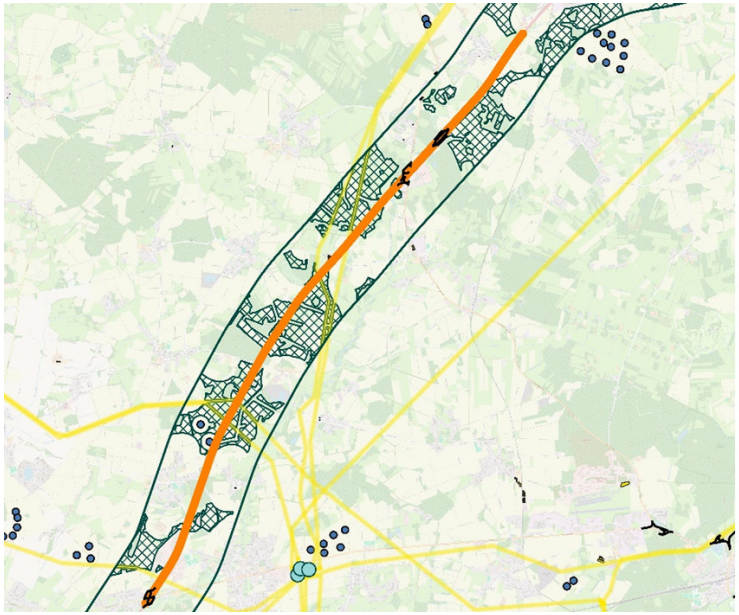
- No visual damage detected
- Load bearing capacity lower than expected → still within reasonable magnitude
  - Important: the concrete modules are located between the wheel tracks!
- No critical joint movements could be detected

- Perspective of the construction crew: The construction concept is feasible and could be potentially applied on longer sections

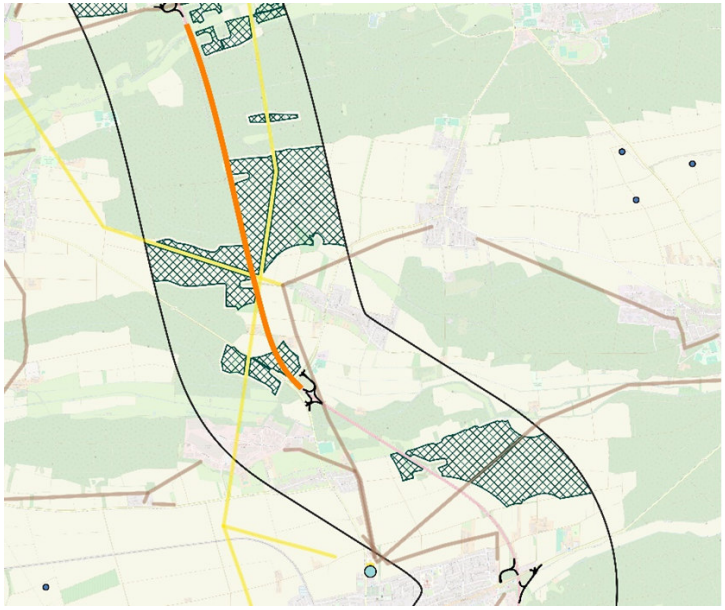
Outlook – potential application on a highway

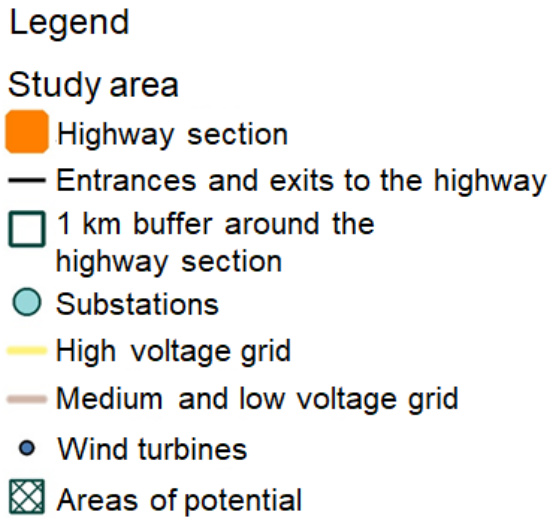
- Selection criteria: Structures (bridges, tunnels), protected areas, available power grids, traffic composition, potential areas for renewable energies, operating model

Example: A1 (10 km – Lower Saxony)



Example: A65 (4 km - Palatinate)





Thank you!

We look forward to the joint discussion.

APT Program

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