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Bundesanstalt für Straßenwesen

Cold Recycling with Foamed Bitumen, one step forward to implementation in Germany's road network

1st International Workshop on
Asphalt Recycling Technologies - ART2024

Federal Highway Research Institute

Section Design and Structure of Pavements
10.09.2024 |Mehdi Kalantari| BASt

What will be presented?

- Why a step forward?
- The APT project and the results
- Next step to implementation

Why a step forward?

- The way to implementation

Technology

- **Cold Recycling BSM with FB**

Learning

- Gaining knowledge
- Laboratory level
- Community: Small

- **PhD (university)**
- **Research project**
- **Laboratory level**

Experiencing

- Gaining experience
- Upscaling, test field level
- Community: Middle

- **Accelerated Pavement Testing at duraBASt**

Transferring

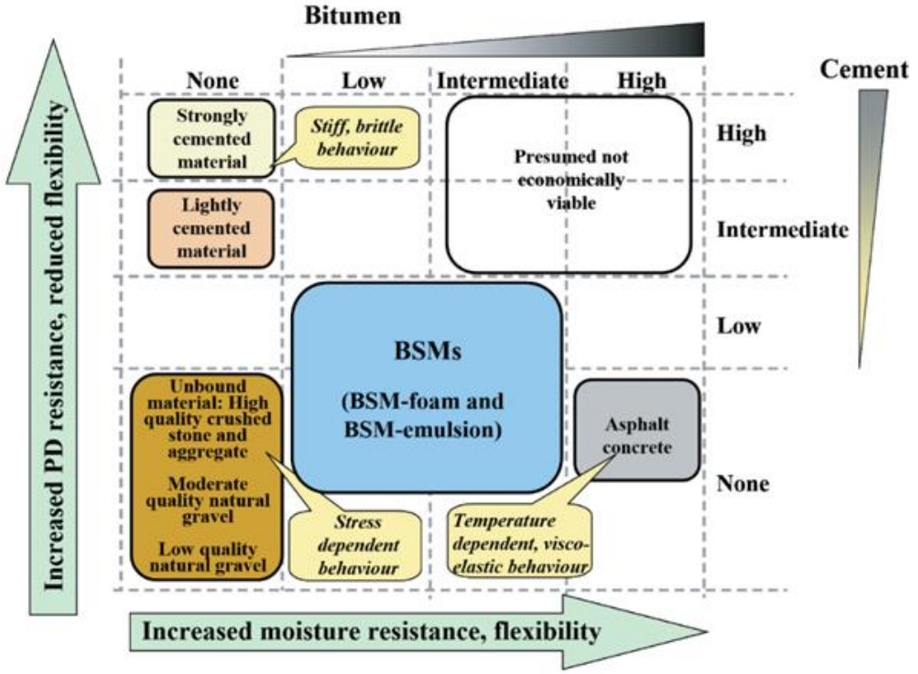
- Exchanging knowledge & experience
- Upscaling, real field pilots
- Community: Big

Implementation

Cold Recycling Technology

- Aggregate mix + Bitumen + hydraulic binder + water
- Aggregate mix → mainly recycled aggregates (+ fresh aggregates)
- Bitumen: Emulsion or Foam
- Hydraulic binder: Lime, Cement, …
- Water → **Curing** over the time
- In-Place or In-plant
- Depending to the binders' content → different behaviors

Cold Recycling Technology

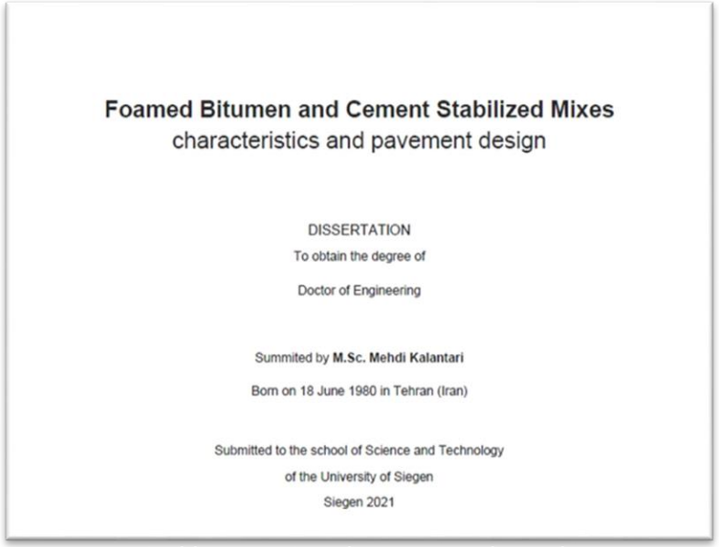


Source: Asphalt Academy, TG2

- Cold Recycled Mixes with high cement and bitumen emulsion content ✓
- Cold recycling with foamed bitumen ?
  - Low cement & bitumen content
  - Positive international feedback
- Interesting !

Learning

- Foamed Bitumen & Cement Stabilized Mixes, University of Siegen (2013)
  - International knowledge review
  - mixing, compacting, curing, testing
  - Effect of binding agents, curing, temperature
  - Stiffness model and pavement structural design
- Foamed bitumen-phase 1, BASt (2017)
  - The laboratory setup, specimen production & testing



Foamed Bitumen and Cement Stabilized Mixes
characteristics and pavement design

DISSERTATION
To obtain the degree of
Doctor of Engineering

Summited by **M.Sc. Mehdi Kalantari**
Born on 18 June 1980 in Tehran (Iran)

Submitted to the school of Science and Technology
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Siegen 2021

http://dx.doi.org/10.25819/ubsi/10082

Loading classes (Million 10 ton)		BK100	BK32	BK10	BK3.2	BK1.8	BK1.0	BK0.3
Pavement layers (cm)	Wearing (DS)	4	3	4	4	4	4	4
	Binder (BS)	8	6	8	6	-	-	-
	HMA Base (TS)	10	8	-	-	-	-	-
	FCSM Base	18	18	19	17	22	19	16
	Anti- frost (FSS)	55	60	64	63	64	67	60
Capacity (Million 10 ton)		103.9	32.6	11.9	3.99	2.4	1.06	0.345

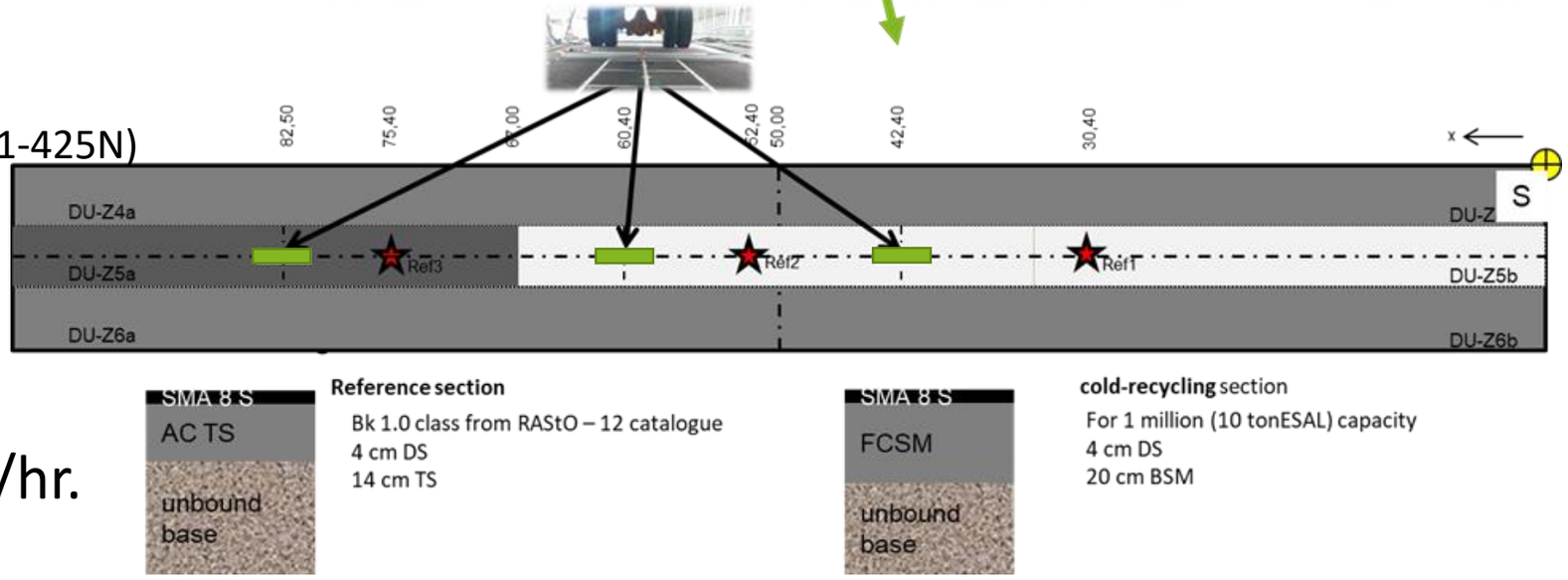
Accelerated Pavement Testing

- earning experience on BSM
- construction 2019
- In-Plant production
- 75% RAP + 25% Sand (0-2mm)
- 2.2% bitumen, 1% cement (1-425N)
- loading 2020 -2022,

total 10.9 Million (10 ton axle)

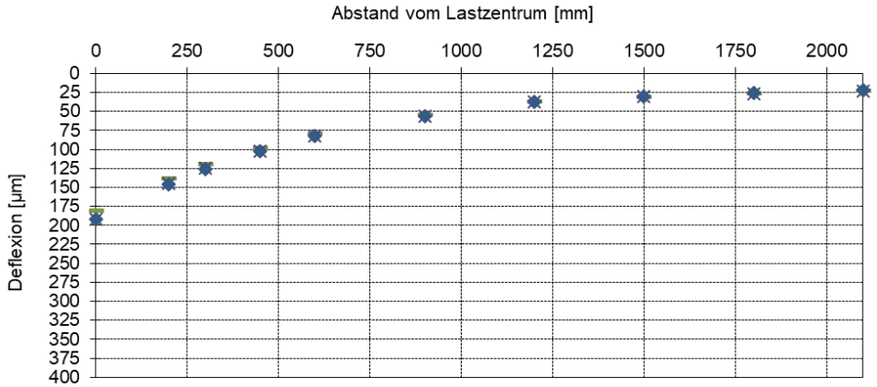
Super single 50 kN, 6000 cycles/hr.

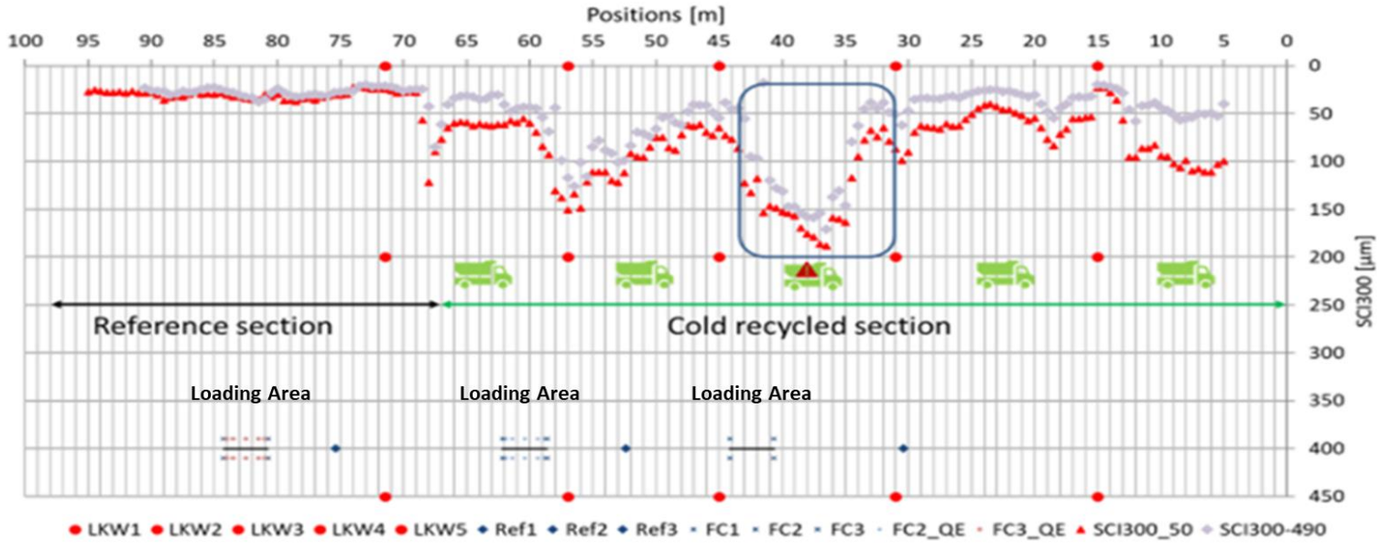
Demonstration, investigation and reference areal of BASt



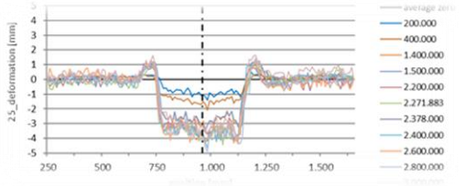
Homogeneity

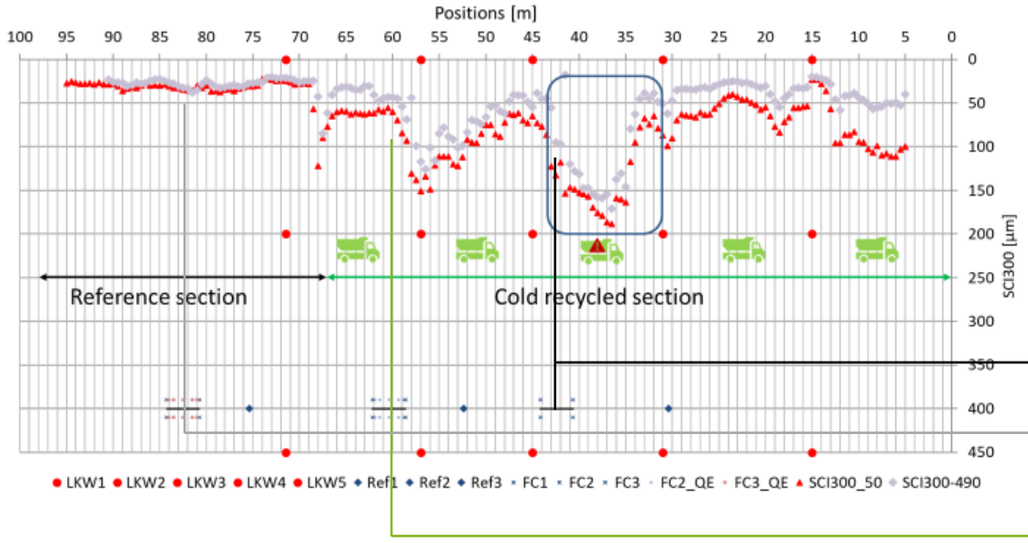
- We used FWD to look at the homogeneity of the bearing capacity along the test section
- SCI300 (d300-d0) is an indicator of the upper layers' bearing capacity
- SCI300 at each 50 cm

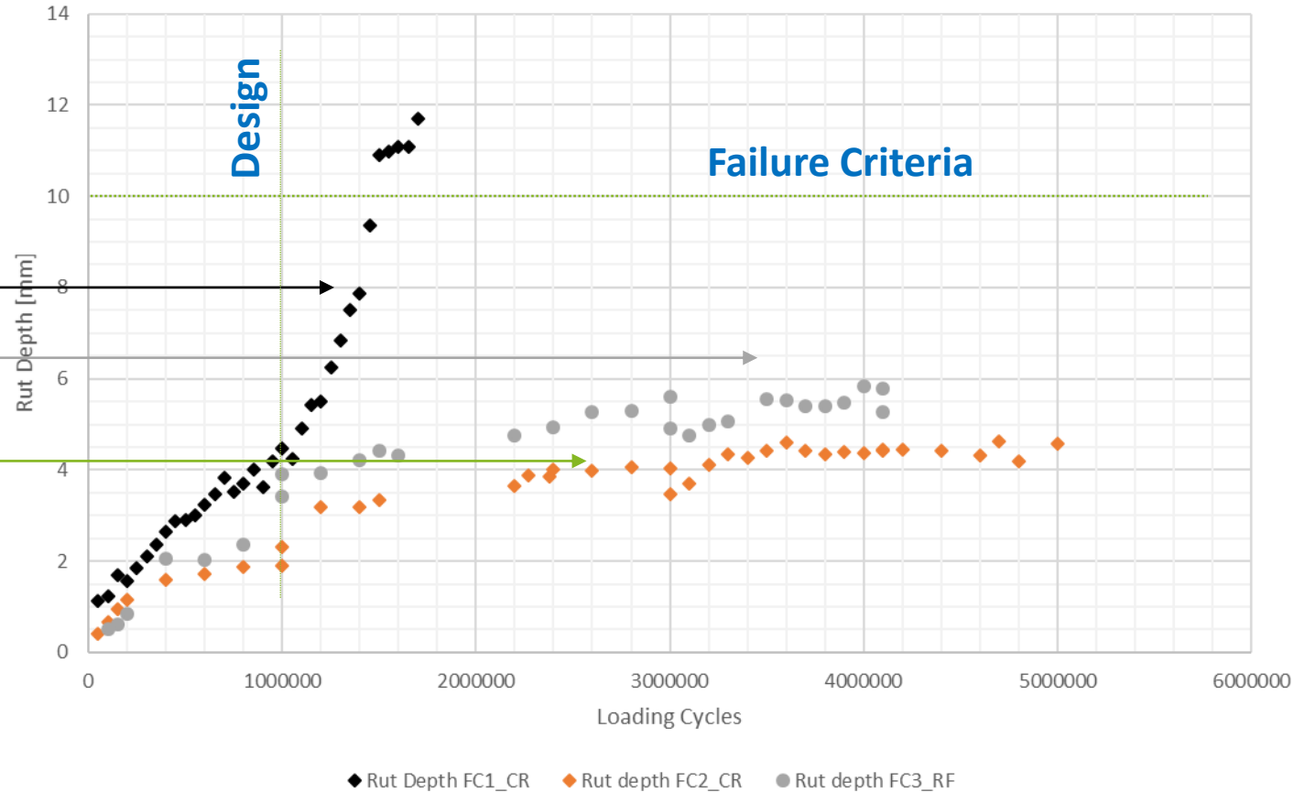




Permanent deformation







- 2 different cold recycling material qualities
- both satisfied the design
- PS: 5 MESAL (10ton) is equal to around 11 MESAL of 8.2 ton

Material behavior

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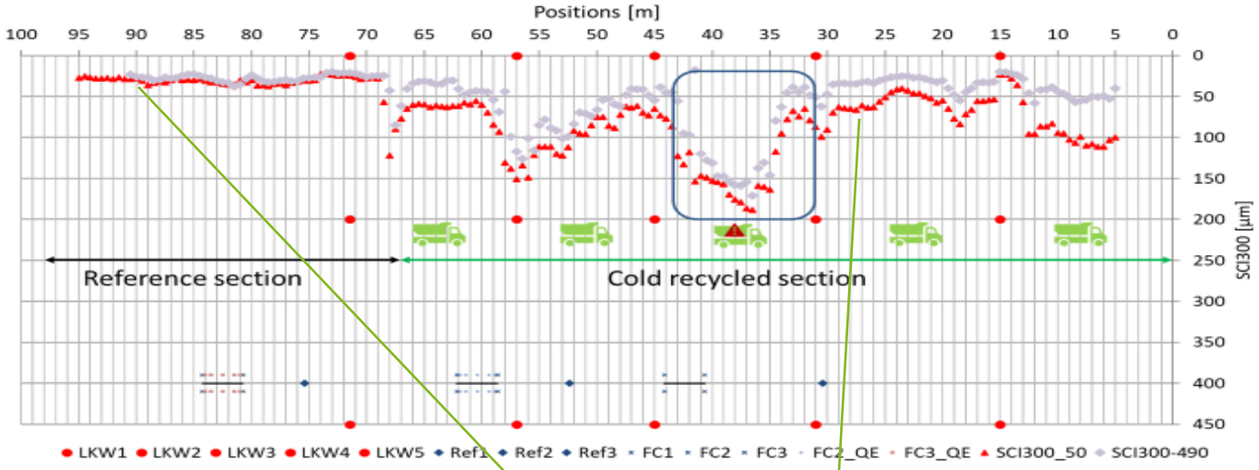
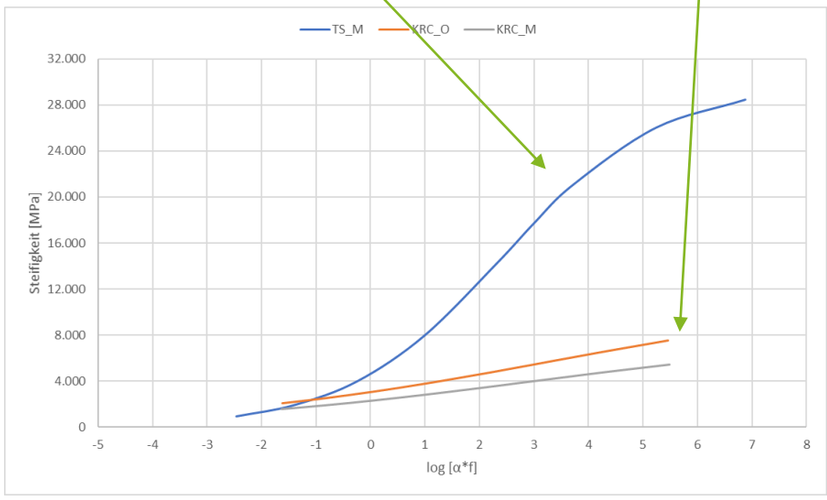
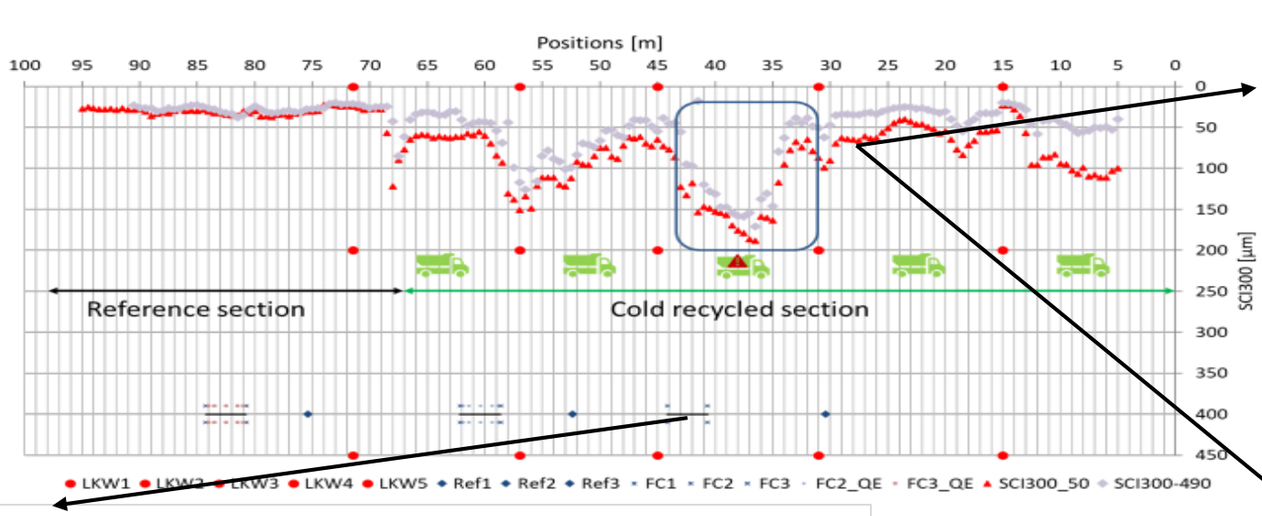


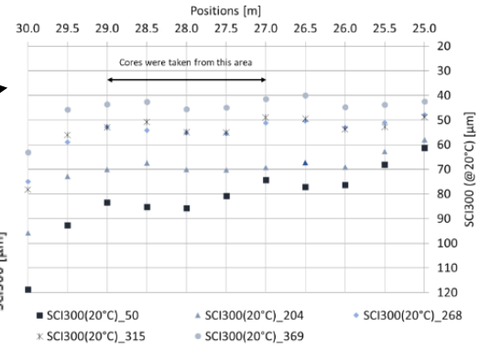


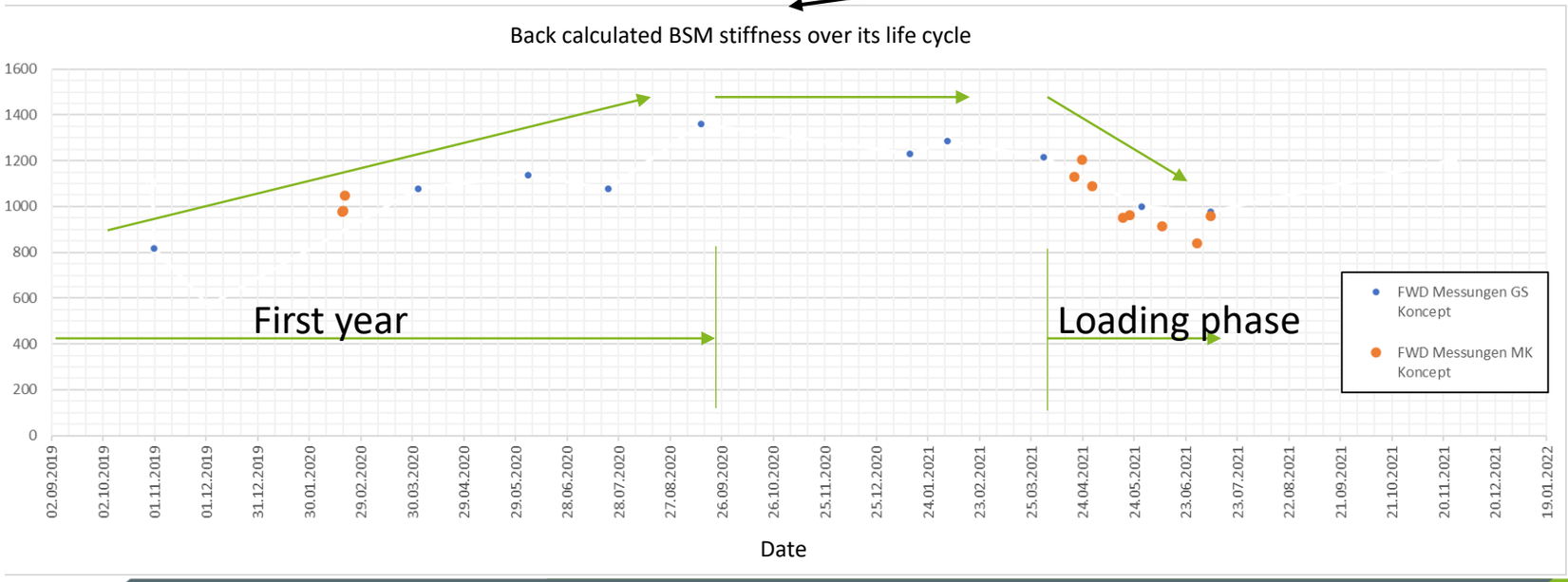
Lower stiffness and temp. dependency than HMA

Material behavior

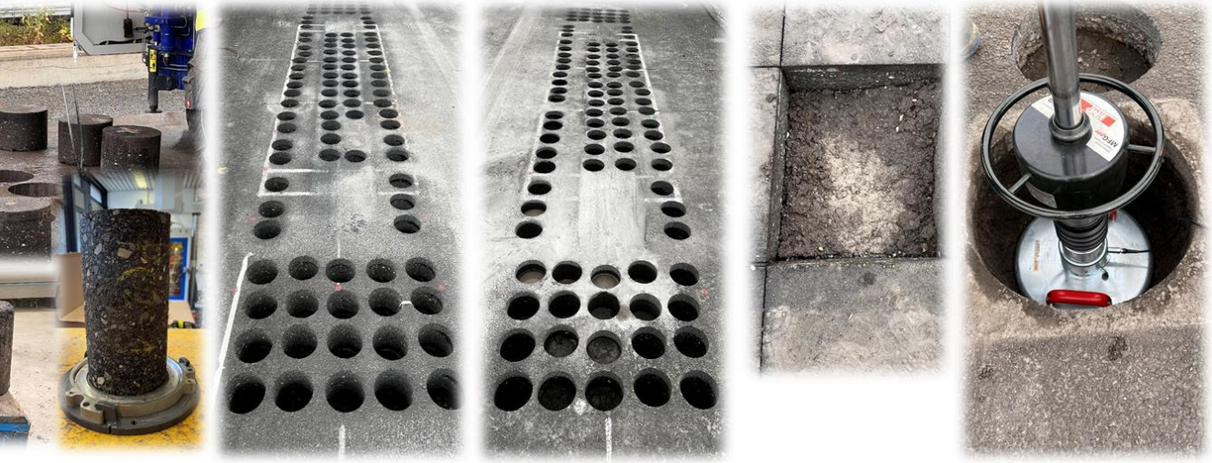
- Curing Phase ~ first year
- Loading phase
  - Setting
  - Damage







Detailed Survey

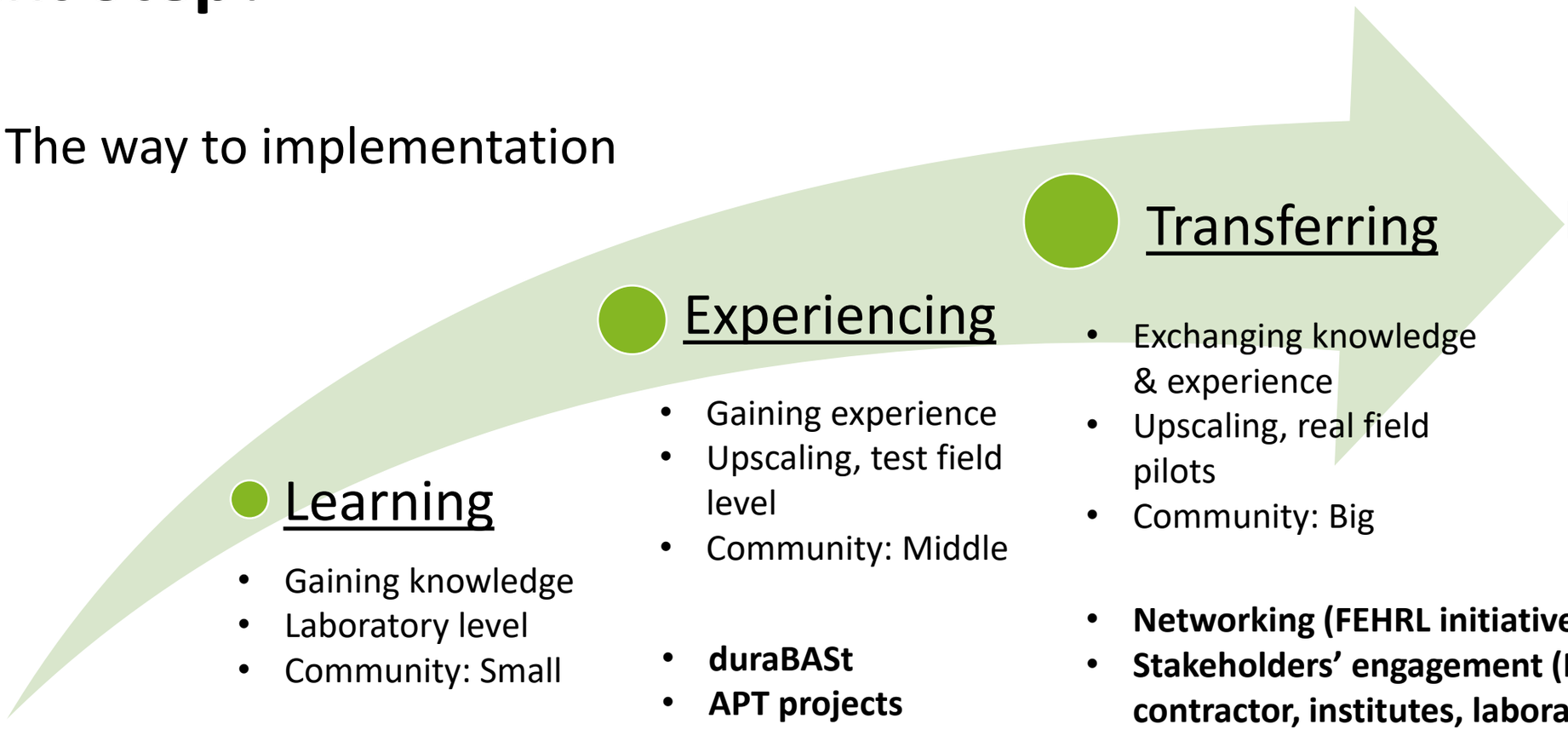


Take away points from APT program

- It is possible to produce and design **pavements** with cold recycled layers with the same or even better **performance** than conventional pavements.
- **Homogeneity** is an important point (input material, preparation, production, construction)
- **Permanent deformation** is the failure mode of BSM
- **Stiffness** is not only temperature dependent but also **stress history** dependent
- **Factor of 1.5** to transfer the thickness of HMA base to BSM **is conservative** but safe for beginners!

Next Step?

- The way to implementation



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Experiencing

- Gaining experience
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- **duraBASt**
- **APT projects**

Transferring

- Exchanging knowledge & experience
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- **Networking (FEHRL initiative, bilateral)**
- **Stakeholders' engagement (NRA, industry, contractor, institutes, laboratories)**
- **Supporting (guidelines, workshops, monitoring)**

Implementation

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Thank you

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