KONFERENCJA - Nowoczesne nawierzchnie drogowe

Recykling w konstrukcjach nawierzchni drogowych

CONFERENCE - Modern Road Pavements

Recycling in road pavement structures

mrp23.ibdim.edu.pl

Warsaw, 18 October 2023

MRP'23

Long Life Pavements with Recycled Concrete in Unbound Granular Layers

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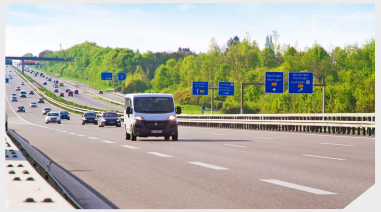
BASt / Germany

What we wish for forever …






What we got after 10 years …




What is the history behind?

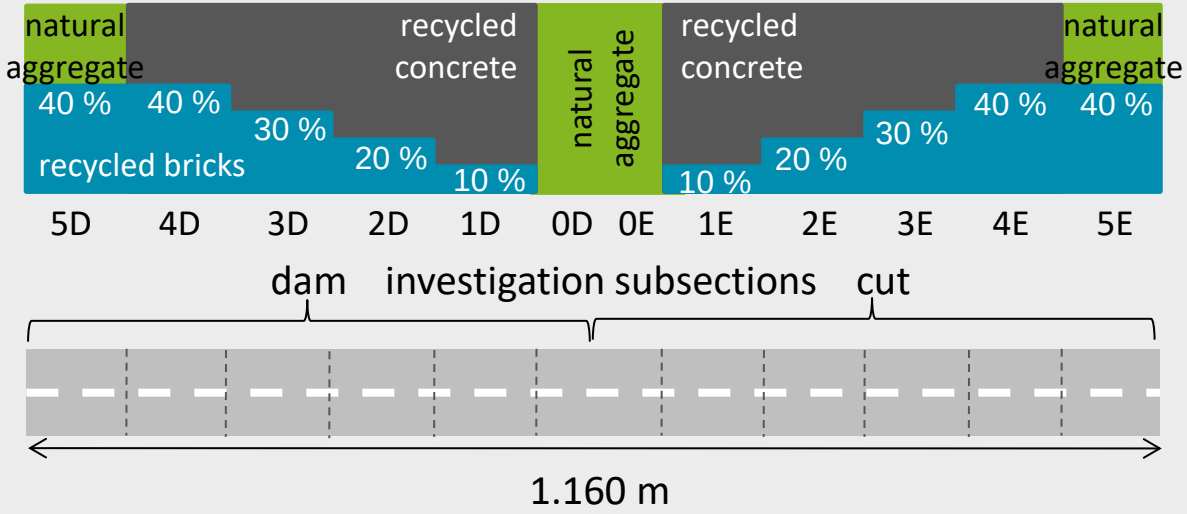
- Is it possible to increase the amount of bricks in recycled material from 25% to 30% without any loss in performance?
- What is the behaviour and performance of such structures under real conditions?

Implementation of an in-situ test section

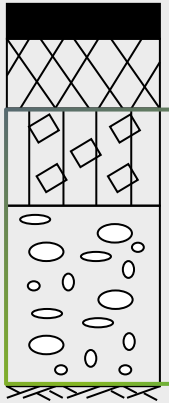
Regular monitoring and examinations

Structure of the Test Track

composition of UGL



RStO 01 – construction class IV



4 cm	asphalt concrete 0/11S
10 cm	asphalt base course 0/22CS
15 cm	unbound base layer 0/45 (six variations)
51 cm	frost protection material 0/22 (six variations)

Material Characterization

sub section	recycled bricks [M.-%]			recycled concrete [M.-%]			Natural aggregate [M.-%]		
	target value	STS	FSS	target value	STS	FSS	target value	STS	FSS
5D	40	45	37	0	33	35	60	21	27
4D	40	39	38	60	54	58	0	0	0
3D	30	29	29	70	66	60	0	0	0
2D	20	17	23	80	78	71	0	0	0
1D	10	10	10	90	80	80	0	0	0
0D	0	0	0	0	0	0	100	100	100
0E	0	0	0	0	0	0	100	100	100
1E	10	11	8	90	84	79	0	0	0
2E	20	21	19	80	68	70	0	0	0
3E	30	31	28	70	64	65	0	0	0
4E	40	41	38	60	53	57	0	0	0
5E	40	33	30	0	43	40	60	22	27

STS – unbound granular base course **FSS – frost protection layer**

Laboratory Test Results (2011)

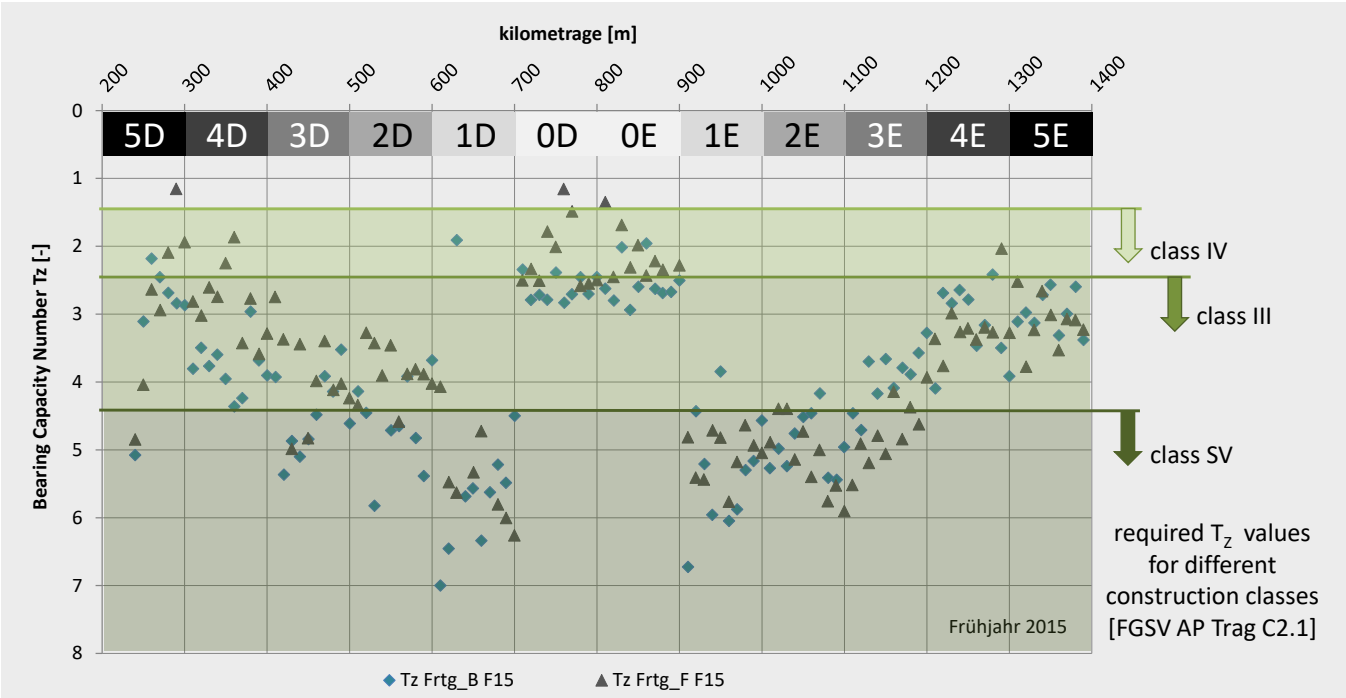
- Low frost heave of origin material and also after excavation
- Broadly consistent results of dry density of origin material and also after excavation
- Conglomerat formation with RC material after excavation
- Coarser grain size distribution after excavation (conglomerat formation)





Results of FWD Measurements

- Requirements for class IV are fulfilled
- T_Z values partly satisfy class SV (heavy traffic)
- Differentiation of different sub-sections



Results of FWD Measurements

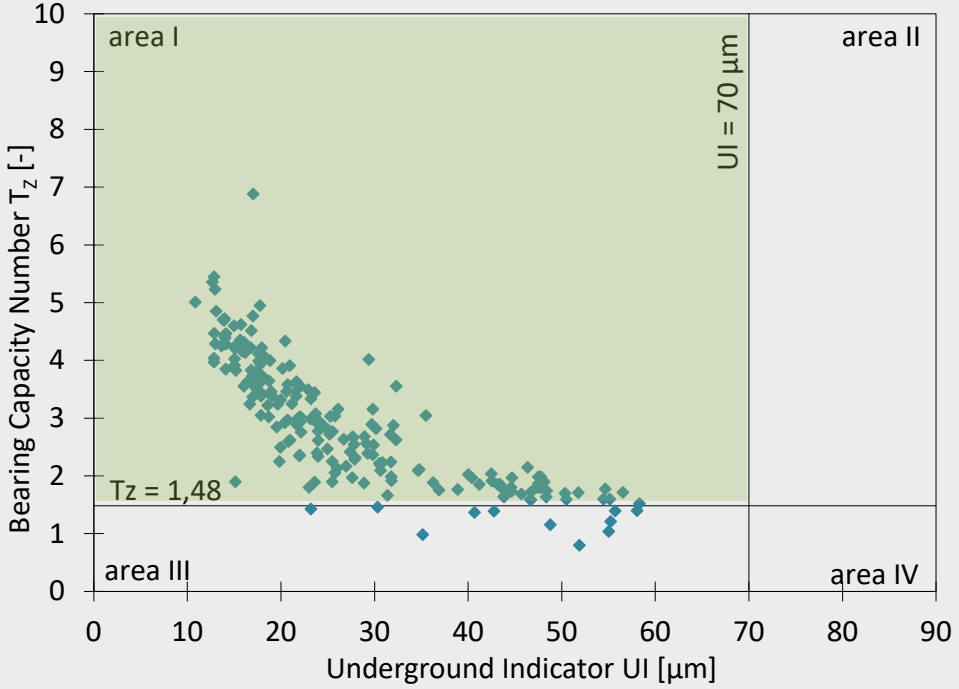
- Requirements for class IV are fulfilled

area I - strong underground
high bearing capacity of bound layers
→ sufficient bearing whole pavement

area II - weak underground
high bearing capacity of bound layers
bound layers ar mor heavily used
→ risk of cracking

area III - strong underground
low bearing capacity of bound layers
→ reinforcement of bound layers required

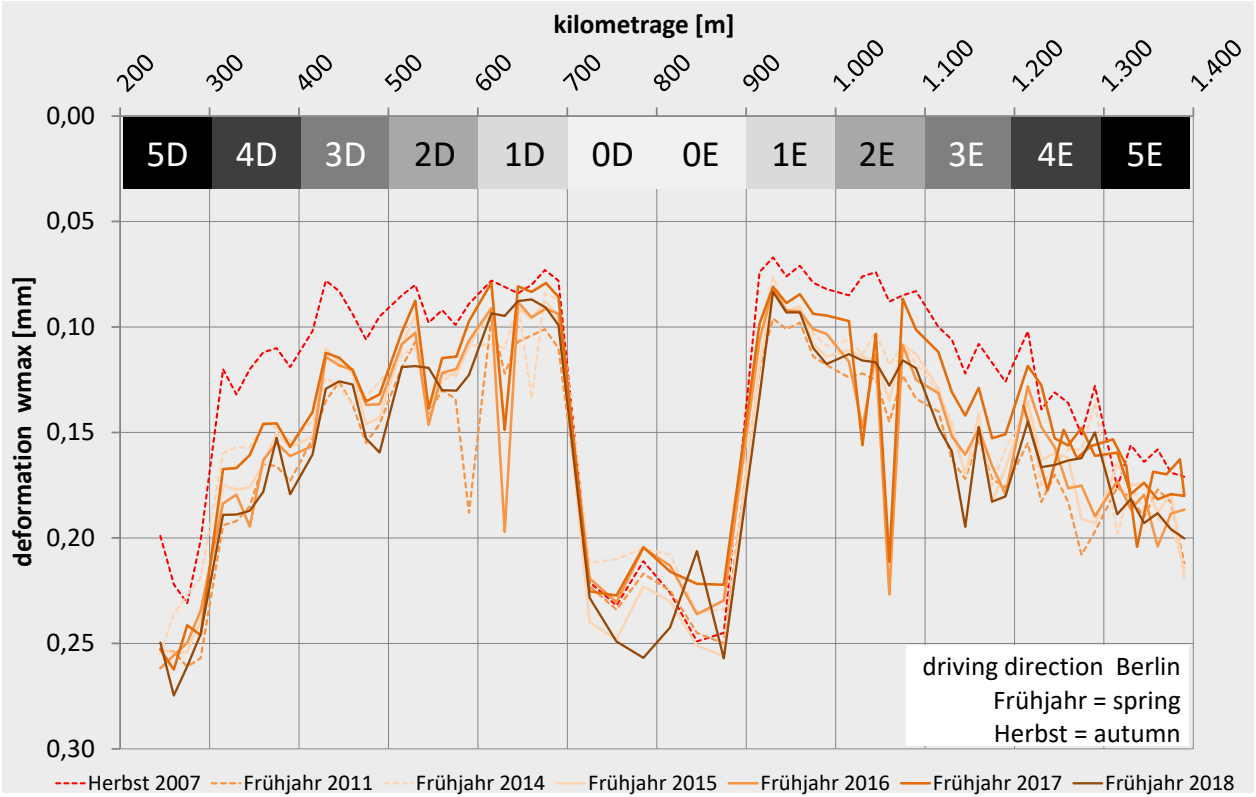
area IV - weak underground
low bearing capacity of bound layers
→ poor bearing capacity of the whole pavement, fundamental maintenance required



FWD Monitoring

- Post compaction
- Differentation of different sub-sections
- Higher amount of recycled bricks, less bearing capacity
- Consistent bearing capacity over the life time

- Punctual loss of bearing capacity



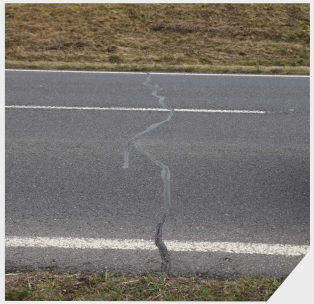
First results

- Good bearing capacity performance for all sub-sections
- no negative effects of high amounts of recycled bricks on pavement performance

Use of 30% of recycled bricks proven to be valid

What about the use of recycled concrete?

Inspection



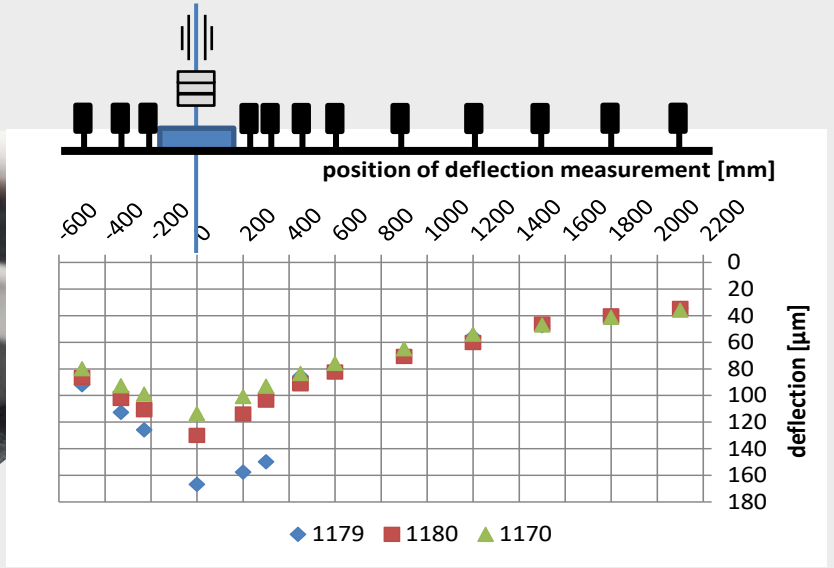
- First single transversal cracks after strong winter 2010/11
- Cracks appear in sub-sections with high amounts of recycled concrete
- No cracks in sub-sections with natural aggregates
- Ongoing transversal cracking without strong winter times
- Cracking of the entire asphalt structure

Asphalt laboratory trials

- low hardening of the bitumen
- sufficient cold resistance

FWD Measurements on Cracks

- Loss of bearing capacity over crack
- Discontinuity in deflection bowl
- …



Rehabilitation work

- Milling of the apshalt wearing course
  (cracks also in the asphalt base course)
- Single excavations for additional investigation

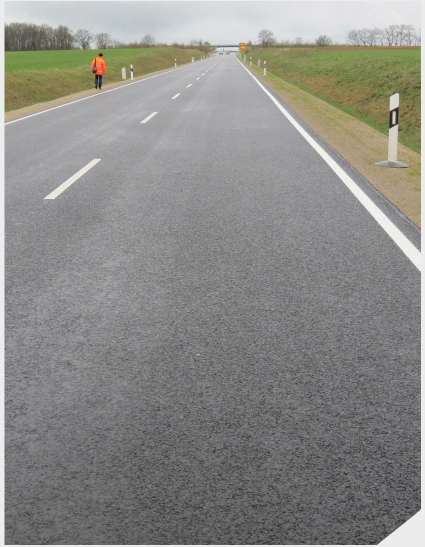
Behaviour of UGLs:

- post-curing of recycled concrete
  (self hardening effects)
- Effect of an anvil for the upper asphalt structure ?
- Reflective cracking ?

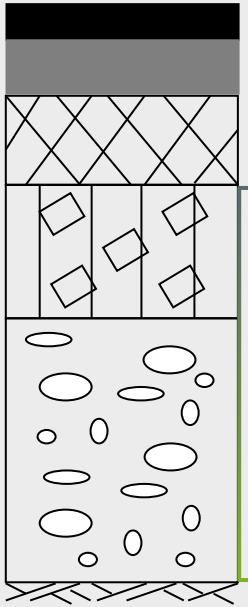
Some Thoughts about Use of RC-materials

- Post curing of recycled concrete
- Different temperature behaviour
- Effects not taken into account in design models

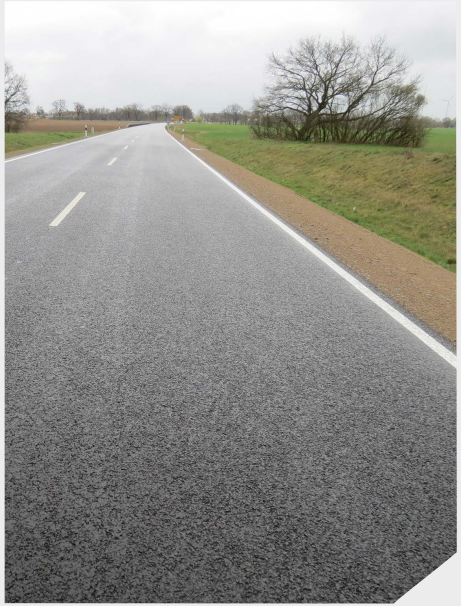
- Better characterization of materials behaviour
- Adaptation of pavement structure



New construction

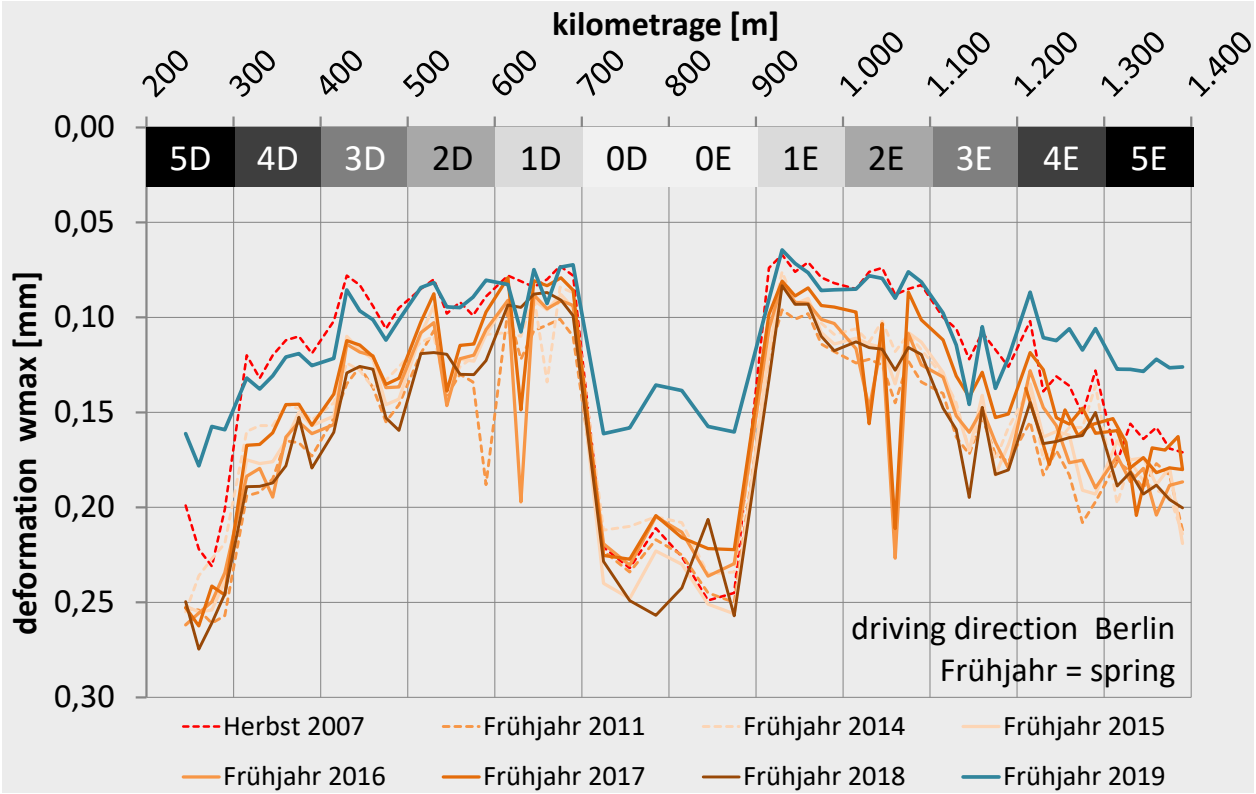


4 cm	asphalt concrete 0/11S (50/70)
6 cm	asphalt binder course
10 cm	asphalt base course 0/22CS (50/70)
15 cm	unbound base layer 0/45 (six variations)
51 cm	frost protection material 0/22 (six variations same as above)

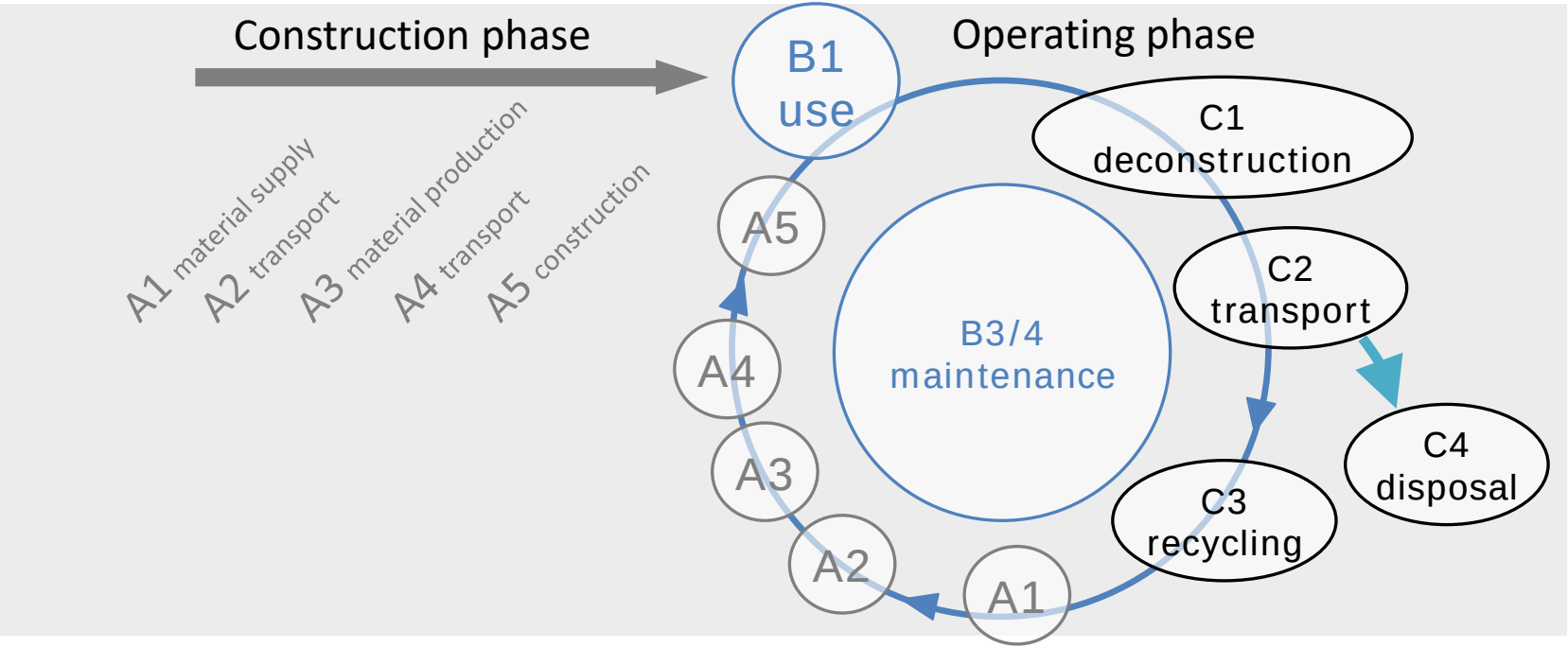


FWD Monitoring after rehabilitation

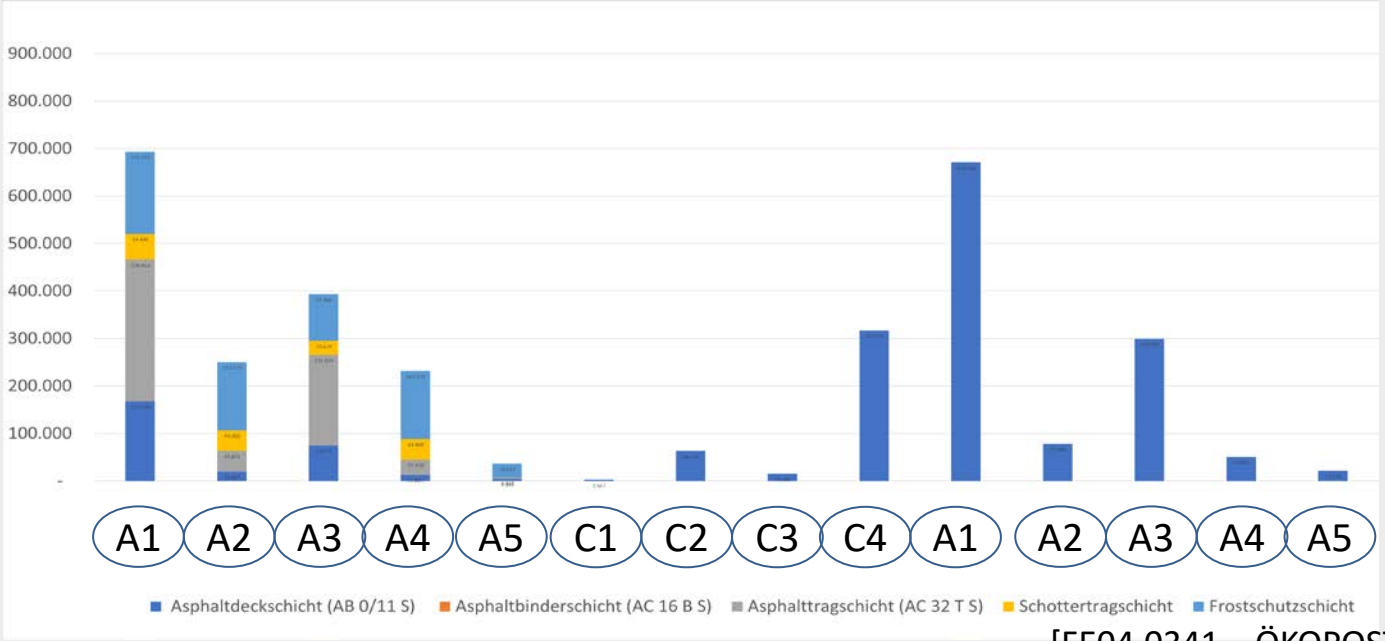
- higher bearing capacity (especially for sub-sections with natural aggregates or high amount of recycled bricks)
- More uniform level of bearing capacity
- …



Lifecycle


Construction phase
A1 material supply
A2 transport
A3 material production
A4 transport
A5 construction
Operating phase
B1 use
C1 deconstruction
C2 transport
C3 recycling
C4 disposal
B3/4 maintenance
A1
A2
A3
A4
A5

Lifecycle – greenhouse gas emissions (old construction)



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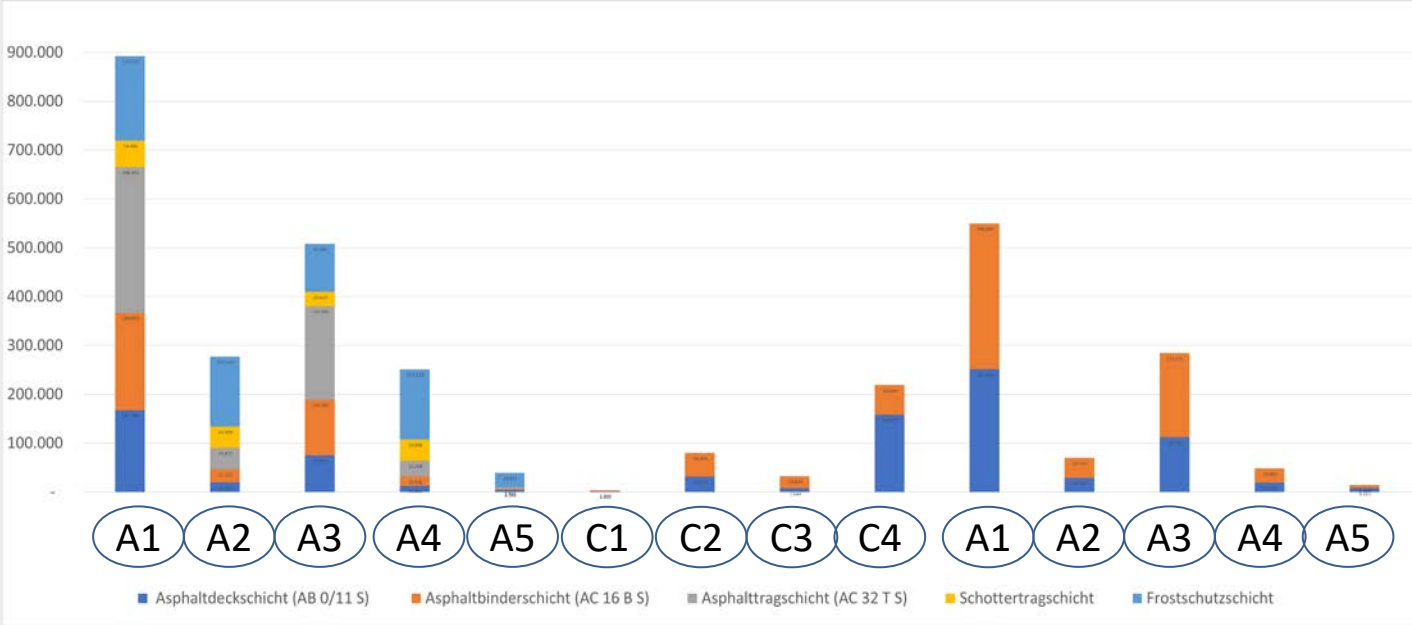
Lifecycle – greenhouse gas emissions (new construction)



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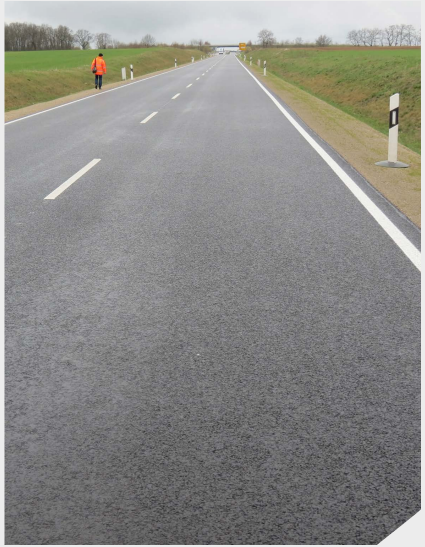
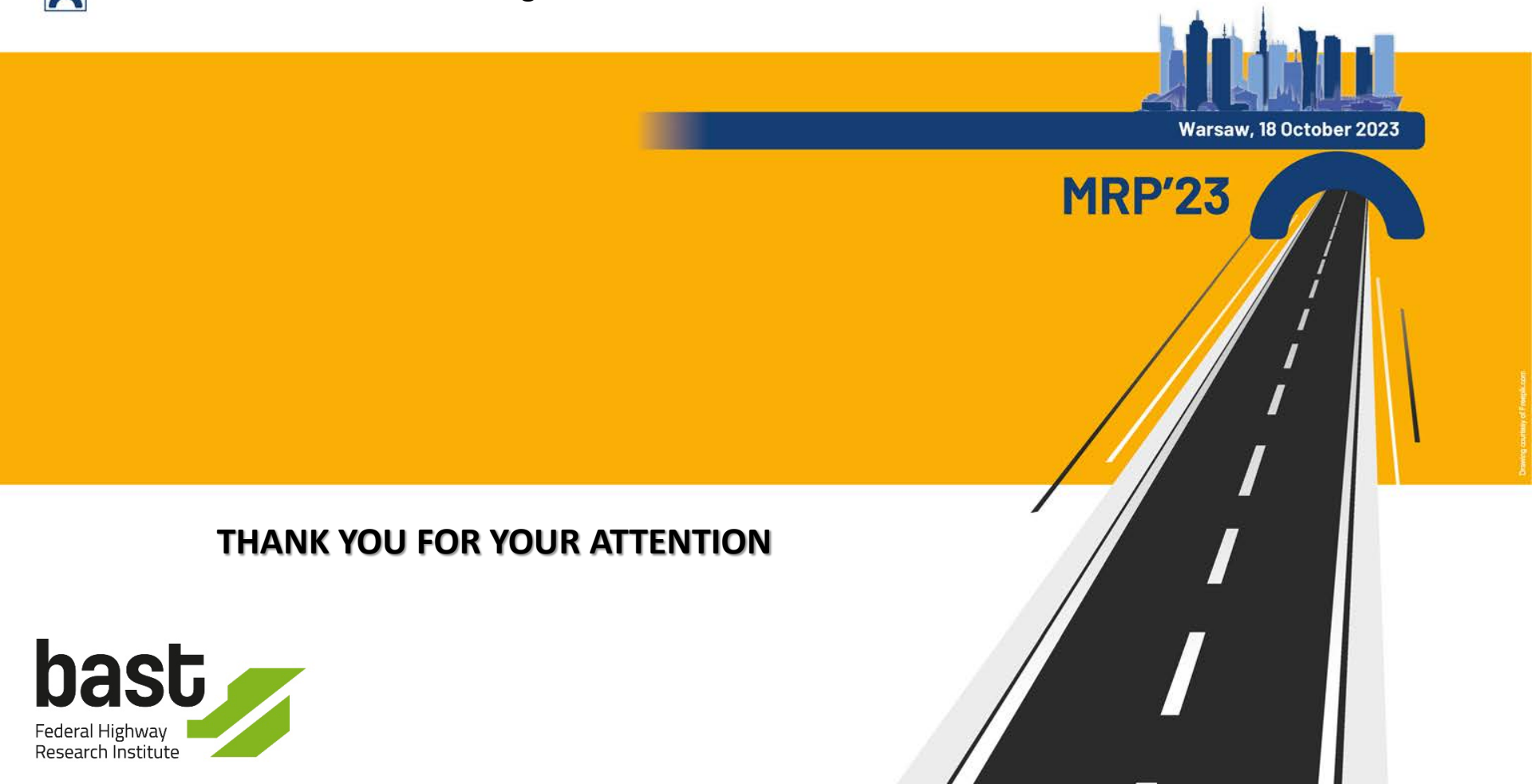
Summary

- Sustainability aspects gain more importance
- Very good bearing capacity for all UGLs
- Good performance of higher portions of recyclied bricks
- Better characterization of materials behaviour for RC materials needed
- Adaption of design models





THANK YOU FOR YOUR ATTENTION

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