14.15 – 14.45 Possibilities to use recycled aggregates in road construction works, examples from Estonia

Ott Talvik, Tallinn University of Technology

14.45 – 15.05 Utilization of by-products of limestone industry in road construction

Sven Sillamäe, TTK University of Applied Sciences

15.05 – 15.30 Overview of the research on use of oil-shale mining waste and oil shale combustion ash

Marek Truu, Technical Centre of Estonian Roads

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EJKL
ESTONIAN RECYCLING
COMPETENCE CENTER

TEEDEKLASTER
ESTONIAN ROAD CLUSTER

POSSIBILITIES TO USE RECYCLED AGGREGATES IN ROAD CONSTRUCTION – ESTONIAN CASE STUDY

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EJKL
EESTI JÄÄTMEKÄITLEJATE LIIT

Euroopa Liit
Euroopa Regionaalarengu Fond

Eesti tuleviku heaks

Seminar in Tallinn, 9th October 2014

SHORT OVERVIEW OF THE PRESENTATION

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Background before the RCA Test Section

Bearing capacity measurements with FWD

Measurements with Percostation

Laboratory measurements with *Percometer*

Little Background of Construction and Demolition (C&D) waste

- Demolishing gives about 900 kg C&D waste per 1 m^2 .
- Estonian Waste Management Plan for 2008-2013 concludes there are about 3…4 ml m^2 buildings and structures that needs demolishing.
- EU directive says that after 2020 70% of C&D waste should be recycled.

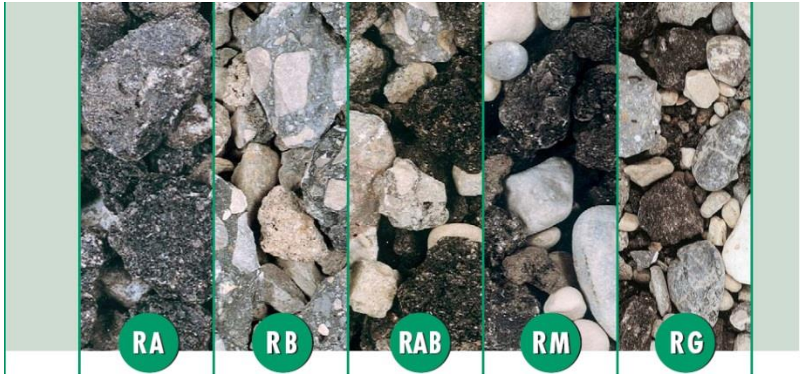
Starting point for Recycled Aggregates Project Why not used in Estonia so far?

- Used only in small private projects not allowed to use on road construction sites.
- General opinion: „If it is a waste then it can not be a material!“
- Requirements in guidelines traditionally were made for natural aggregate and too high for RCA to achieve.
  - For example in other EU countries the requirements are lower, so RCA also meets the standards.
- To prove the material for the Road Authority we needed our own test section!

What was driving us?

Research reports and guidelines in Europe countries

- **ALTernative MATerials**, 1998-1999, group from 7 countries, which was leaded by TRL (UK) gave an overview of using recycled materials.



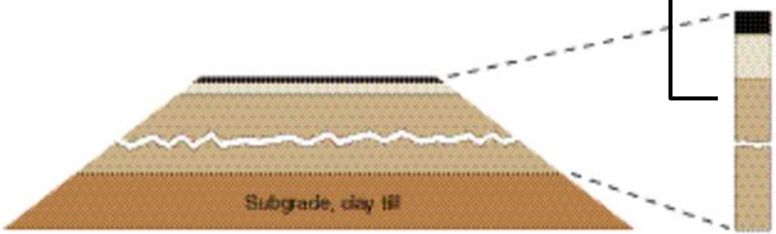
- Austrian guidelines (BRV, 2009)
- Danish guidelines (Vejdirektoratet, 2002)
- Norwegian guidelines (Statens vegvesen 2005)
- Finnish guidelines (Tiehallinto, 2000)
- Swedish guidelines (Vägverket, 2004)

What was driving us?

Test sections in Nordic countries on high volume roads

In Sweden, built in 1997

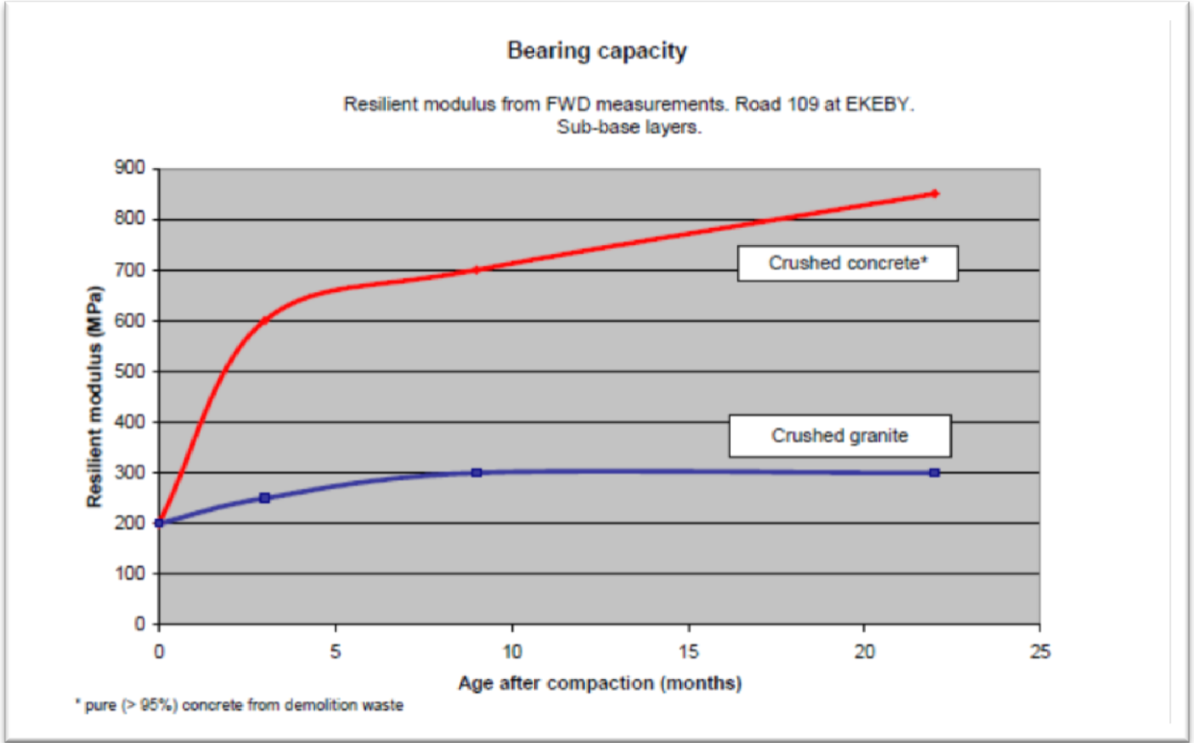
Stone Mastic asphalt ABS (35 mm)
Asphalt base layer AG (95 mm)
Crushed concrete(785 mm)



In Norway, built in 2003

What was driving us?

High bearing capacity of crushed concrete layer

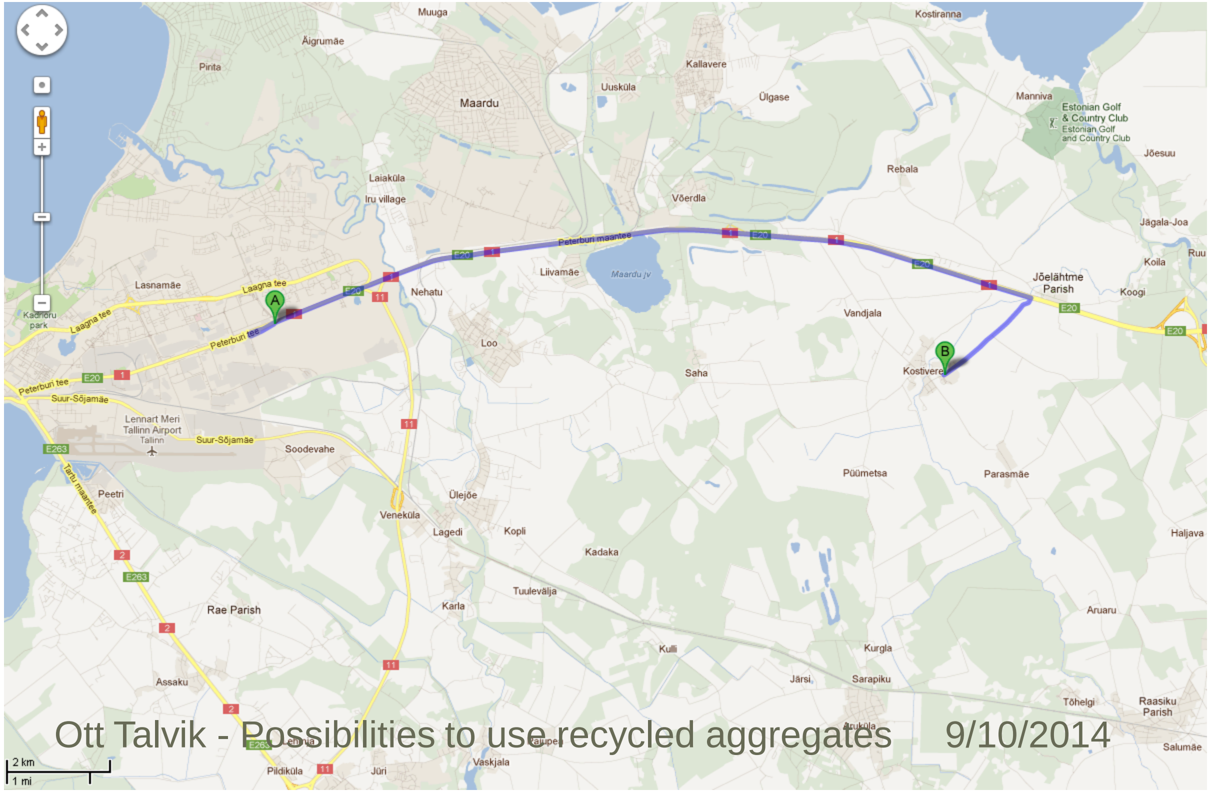


A short chronology of the RCA Test Section project

- 2010 – starting an overview study of crushed concrete at Tallinn University of Technology
- 2011 February – starting negotiation with Estonian Road Administration for finding test road possibility
- 2011 May – final confirmation from Road Administration
- 2011 July – tender for finding Contractor
- 2011 Sept-Oct – Road Construction with crushed concrete unbound base course
- 2011 Oct - … continuous monitoring of the RCA Test Section

To prove the material for road authority we needed our own test section

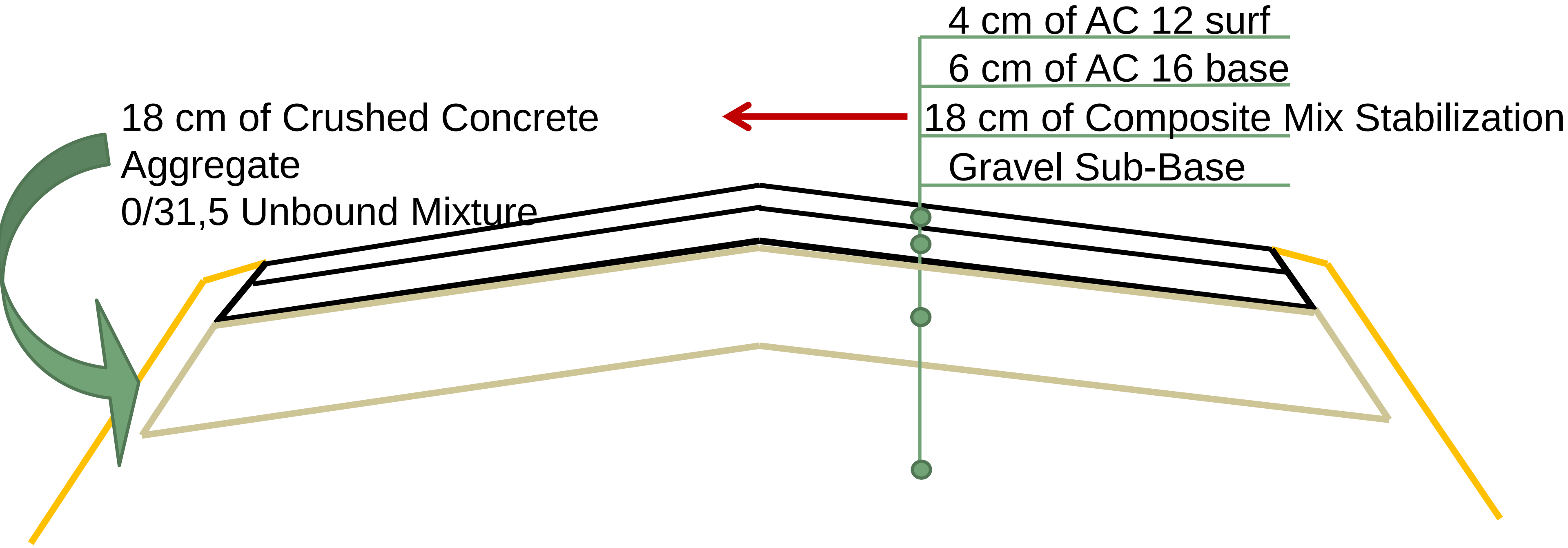
Location of the production site (ATI Grupp, Tallinn) and test road section (Kostivere), distance -19 km



Maardu-Raasiku road (No11103)
Test section km 3,4-3,9

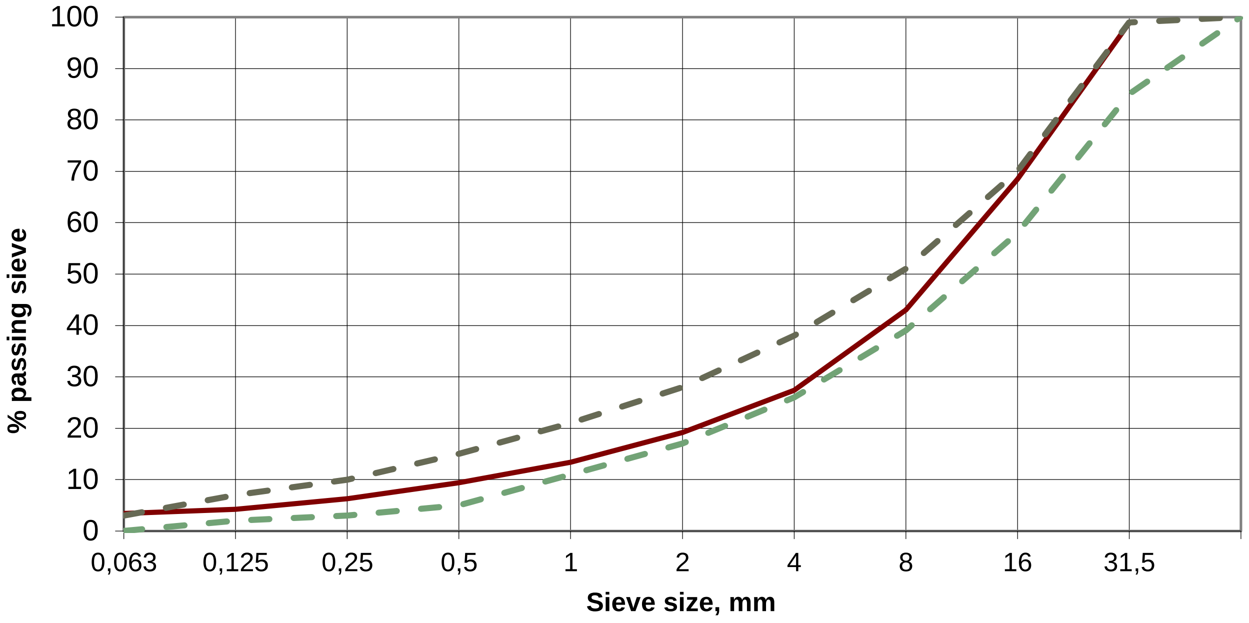
Maardu-Raasiku road before reconstruction, 04.08.11

Road Pavement before and after replacement with RCA



Used unbound mixture – 0/31,5

Typical 0/31,5 mixture grading curve compared to EVS-EN 13285:2010 mix category G_O



Construction Period, 05.10.11

Construction Period, 07.10.11

Construction Period, 10.10.11

Material Quality Control

Stages of Quality Control

- Test samples to the Laboratory:
  - From production
  - On site before laying
  - On site after laying and compaction
- Bearing Capacity measurements:
  - On the sub-grade
  - On the base course
  - On the top of the asphalt pavement

Measurements on the base course

- FWD
- Portable FWD Inspector
- German Dynamic Plate (HMP LFG)

Bearing Capacity Measurements with Falling Weigth Deflectometer (FWD)

FWD on gravel sub-base

FWD on the asphalt pavement

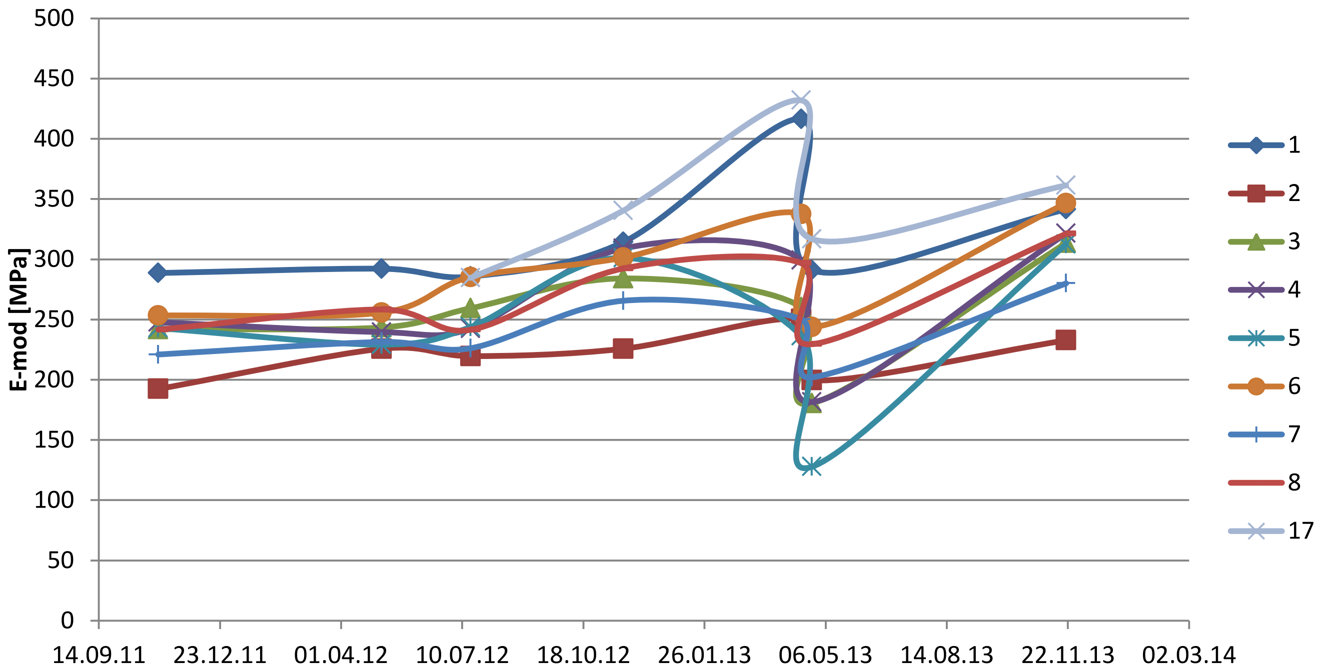
Bearing Capacity Measurements with FWD on Asphalt Pavement 2011-2013

Control points number 1-8 in every 50 m. Point number 17 was added in 2012 at Percostation location.

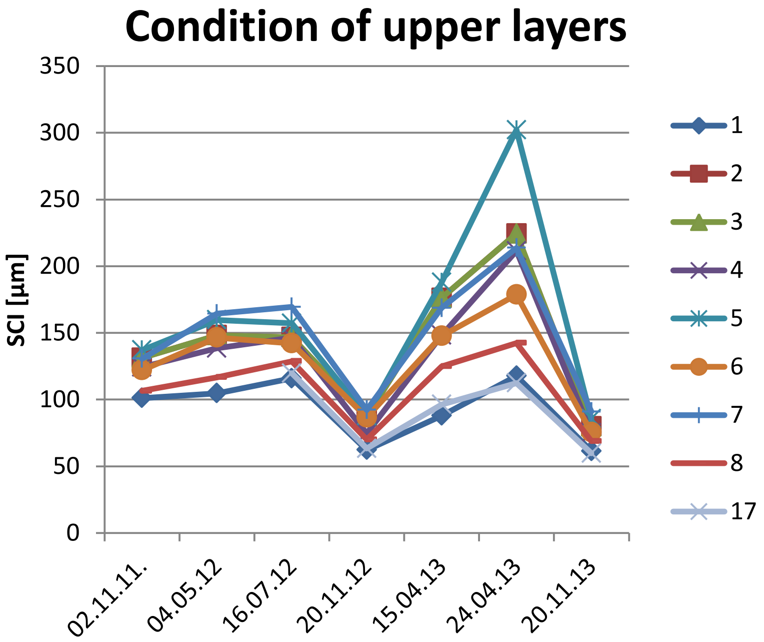
Lõik	Punkti nr	Mnt nr	Km	02.11.11	04.05.12	16.07.12	20.11.12	15.04.13	24.04.13	20.11.13
				Emod, MPa	Emod, MPa	Emod, MPa	Emod, MPa	Emod, MPa	Emod, MPa	Emod, MPa
CRUSHEC CONCRETE BASE	1	11103	3,504	289	292	286	314	416	291	341
	2	11103	3,554	192	226	220	226	250	200	233
	3	11103	3,604	242	243	259	284	260	181	314
	4	11103	3,654	248	240	243	309	299	181	321
	5	11103	3,703	243	229	244	301	236	128	313
	6	11103	3,753	253	256	285	301	338	244	347
	7	11103	3,803	221	231	226	266	250	202	280
	8	11103	3,863	242	258	241	292	297	230	321
	17	11103	3,489			285	340	432	317	361
STABIL. KS 32	13	11103	3,050		288	329	328	476	352	372
	14	11103	3,100		361	382	401	525	308	487
	15	11103	3,150		410	436	473	749	476	475
	16	11103	3,200		481	522	538	631	459	570

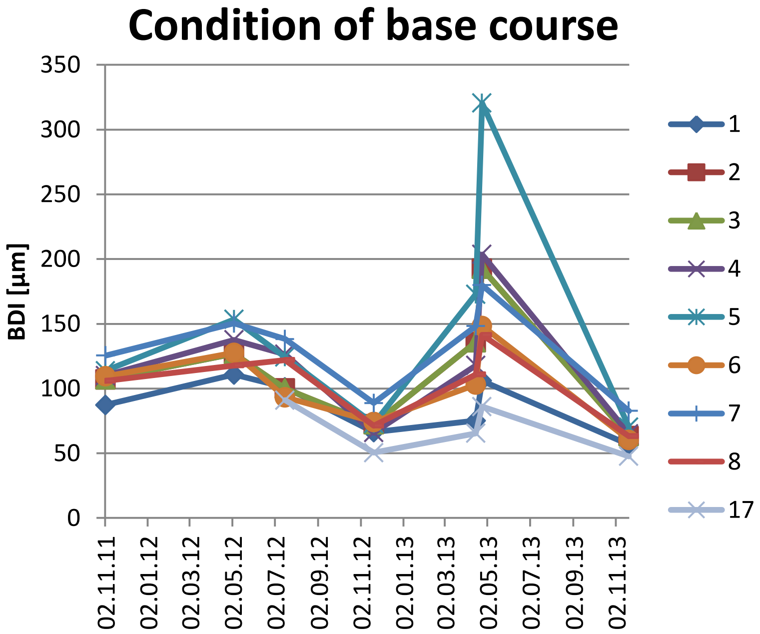
Comparison of FWD measurements on top of asphalt pavement 2011-2013

Aprillis 2013 on teostatud järjestikune mõõtmine 10 päevase vahega, et tabada kevadist sulamisest tingitud kandevõime kaotust.



Variation of FWD deflection basin parameters





Percostation – what is this?

- Percostation is a system for continuous monitoring of dielectric constant, electrical conductivity and temperature of materials.
- It was developed by Estonian company Adek OÜ in cooperation with the Finnish company Roadscanners OY for monitoring the critical bearing capacity of roads.

- Example from Lapland

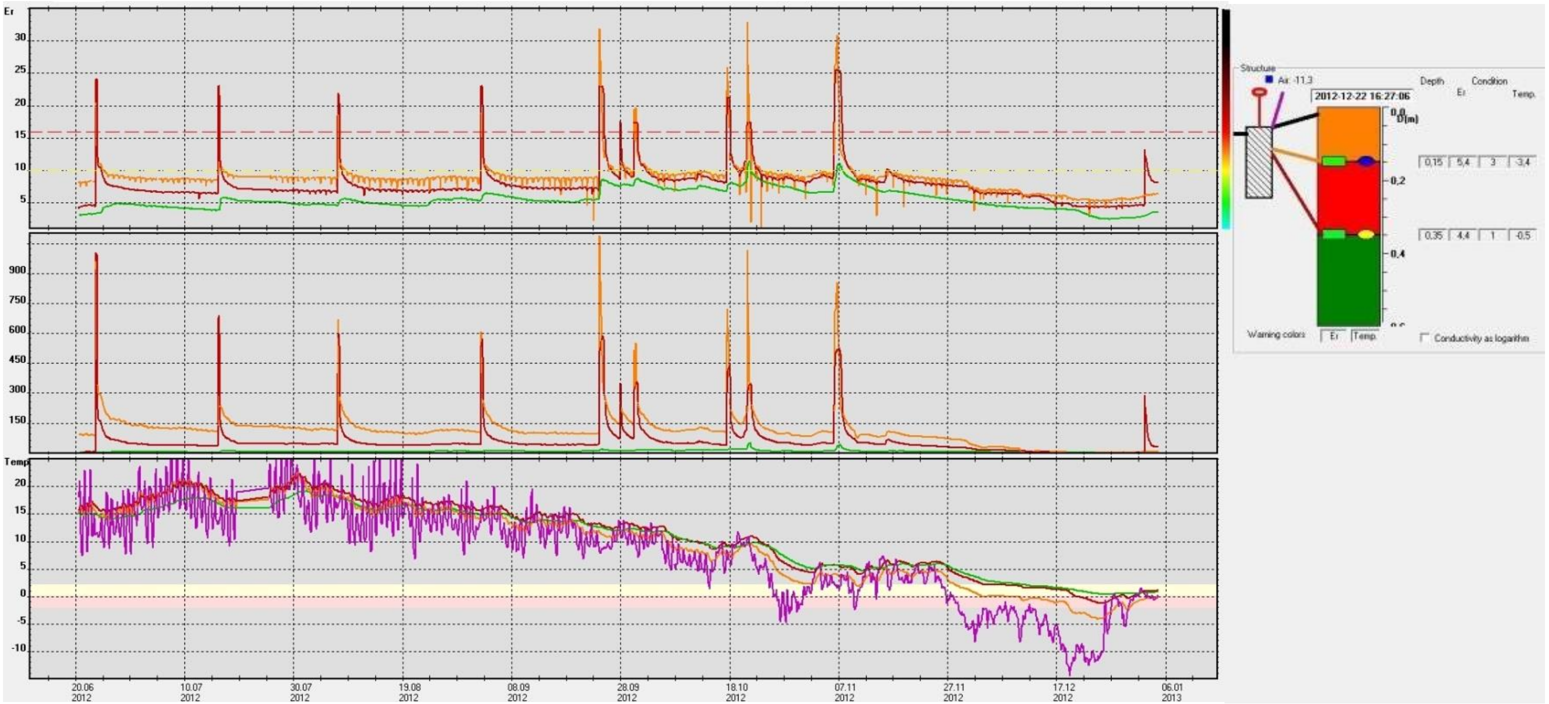
Monitoring of water content in base course layers by dielectric conductivity measuring station



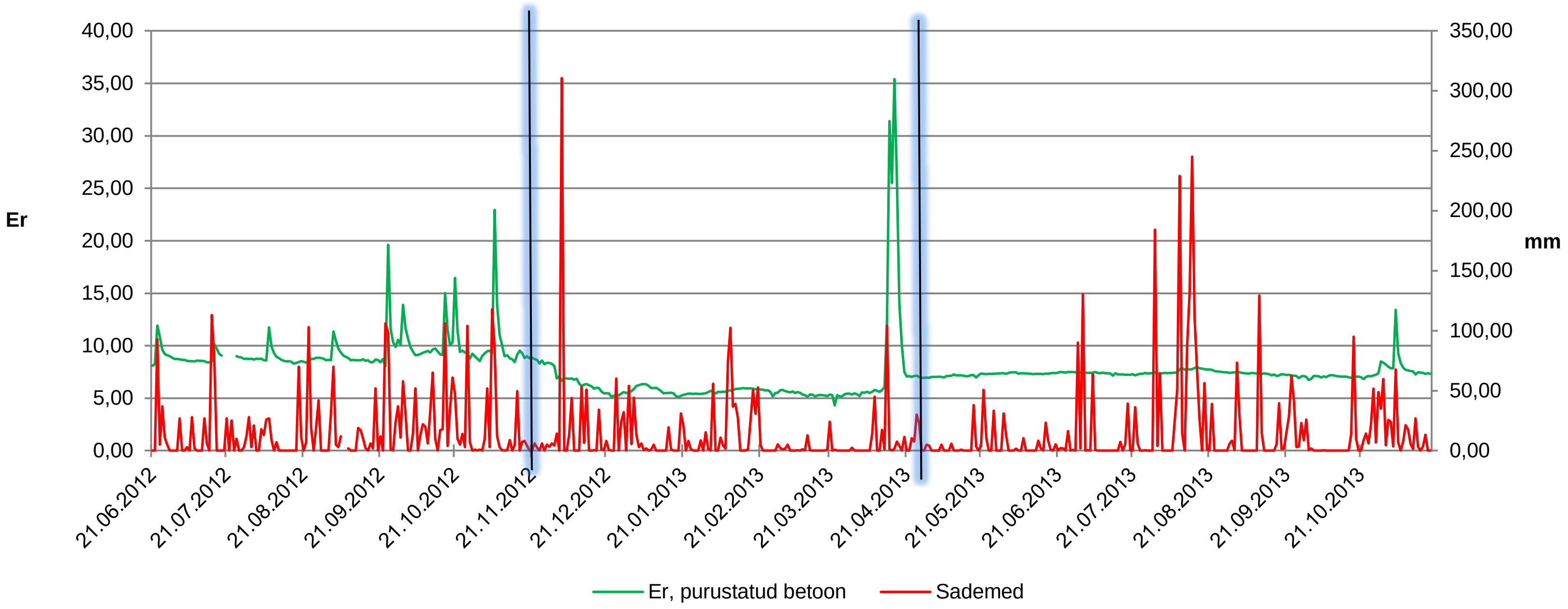


Percostation sensors are
installed into the road structure on depths from top of the asphalt pavement: 24, 33, 63 cm.

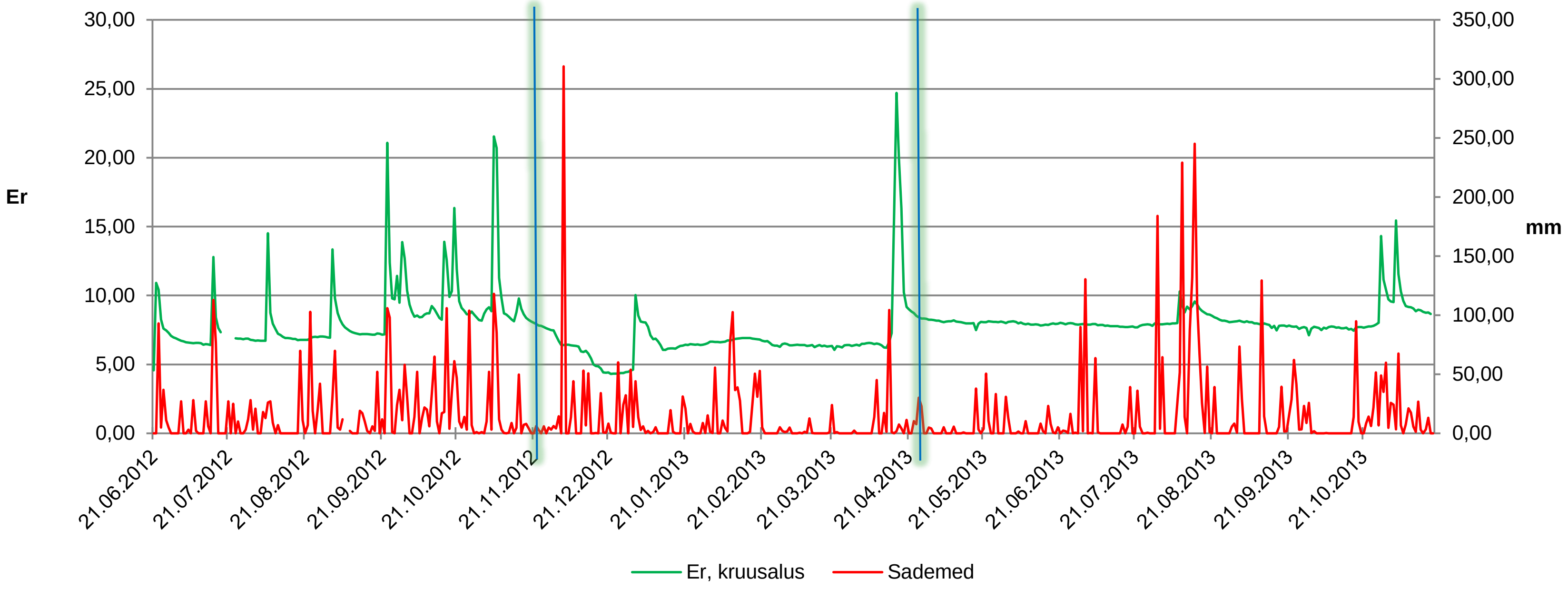
period from installation until the end of year 2012



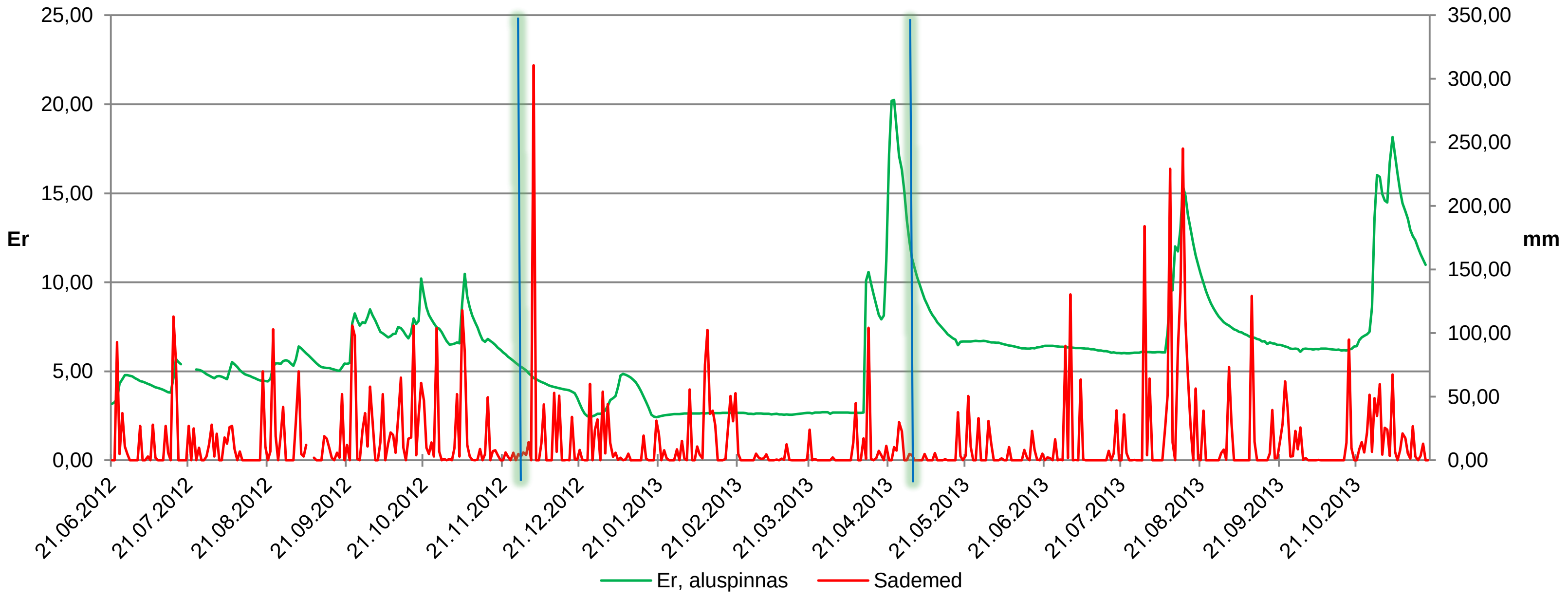
Dielectrical permittivity in 24 cm depth compared to precipitation near (Jägala) weatherstation



Dielectrical permittivity in 33 cm depth compared to precipitation near (Jägala) weatherstation



Dielectrical permittivity in 63 cm depth compared to precipitation near (Jägala) weatherstation



Laboratory Measurements with Percometer – Tube Suction Test (TST)

The Tube Suction Test was developed by Saarenketo and Scullion at the Texas Transportation Institute (TTI) for investigating the suction properties of various base course aggregates, and has been further tested and developed during 1996-2000 at TTI, the Tampere University of Technology, in the laboratory of the Lappi Region of Finnra, and at the University of Saskatchewan.

Preparing the material for TST

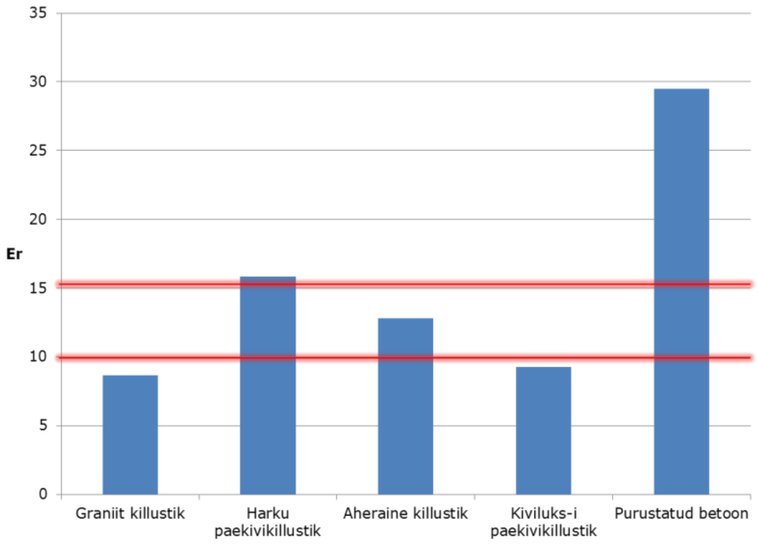
Test materials – fractions 0/8 mm	Probes in tubes

Execution of TST

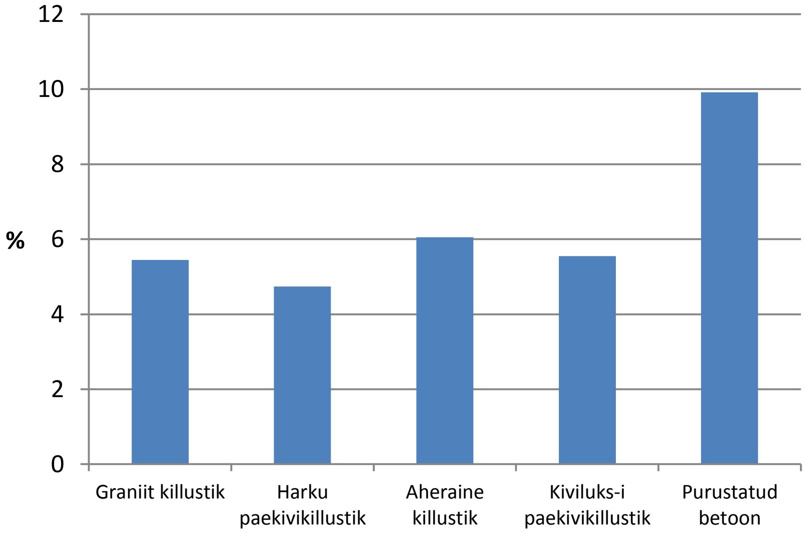
Conditioning of test probes	Testing with Percometer

Results from TST

Dielectrical permittivity Er on optimal water content of the material

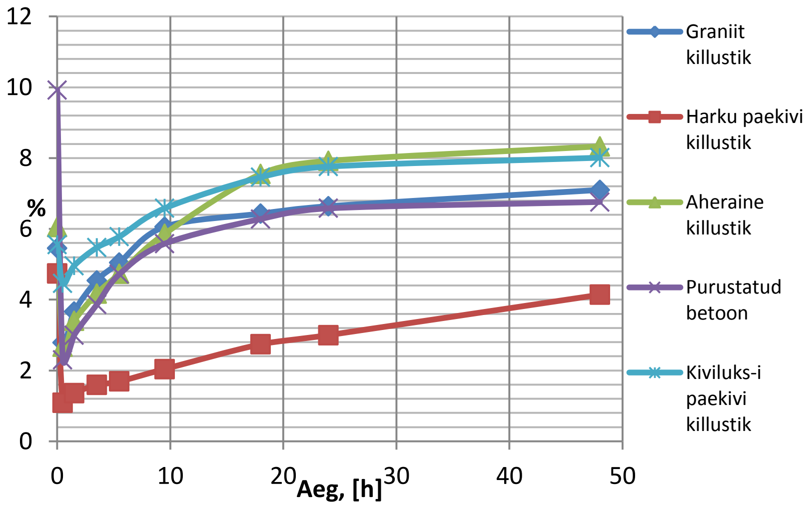


Optimal water content

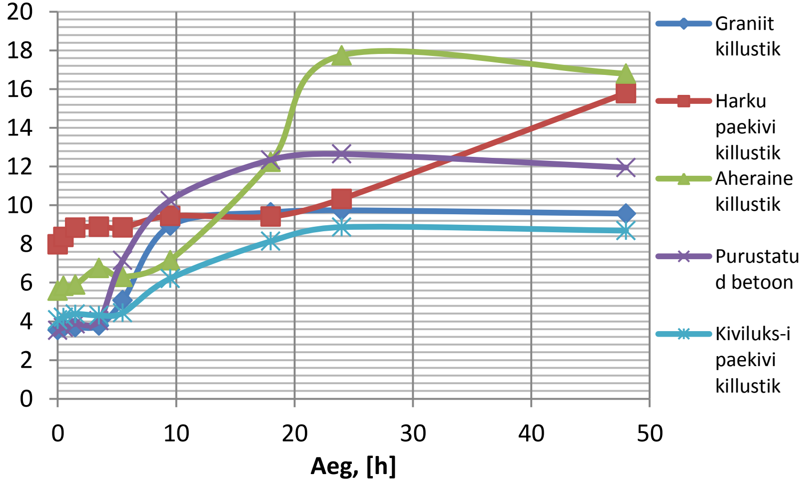


Comparison with natural aggregates (1)

Change of water content, 48 h

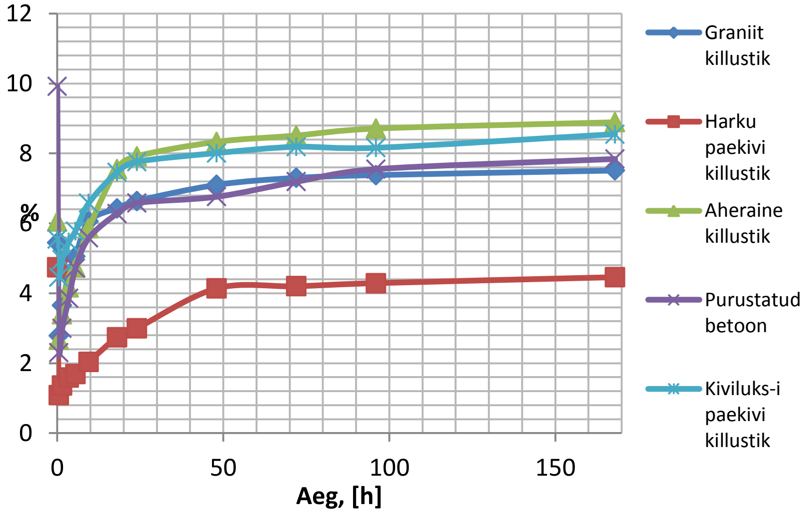


Dielectrical permittivity, 48 h

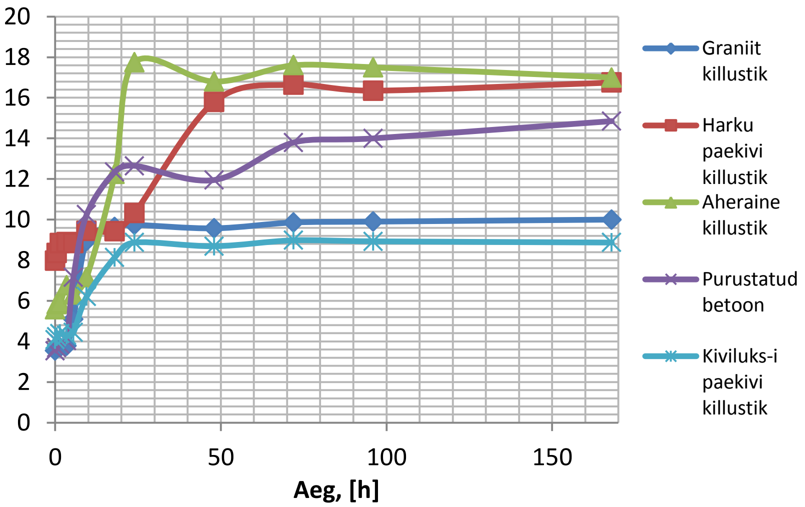


Comparison with natural aggregates (2)

Change of water content during the test



Dielectrical permittivity during the test



Conclusion of work done so far

- RCA basic properties are good enough to use the material in Low Volume Roads base courses.
- Well known negative sides of RCA properties are high water susceptibility and low frost susceptibility in laboratory tests which have been disapproved with good field performance.
- FWD measurements are showing good Bearing Capacity and sufficient pavement performance as it was expected.
- If measuring dielectric properties continuously it is possible to assess seasonal variations in the water content and also the bearing capacity condition of RCA base course and pavement structure.

Changes in regulation after some years

- We have now RCA mentioned in guidelines but not in the best way – possibilities to use are very limited.
- According to the Road Administration Guideline the RCA is allowed to use on pathways and on cycling roads and on small parking lots or on roads where AADT < 200 car/day. Technical requirements: $C_{50/30}$, **LA_{35}**, F_4, FI_{35}, UF_3 (f_4); pH < 11.
- According to the Estonian Road Designing Norms the technical requirements for the same use are: $C_{50/30}$, **LA_{40}**, F_4, FI_{35}, f_4; pH < 11.

To conclude

The next step should be preparation for selective demolition and the regulation of giving out licenses to demolish buildings.

THANK YOU FOR A KIND ATTENTION!

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