



TALLINN UNIVERSITY OF
TECHNOLOGY

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FROM C&D WASTE TO MATERIAL WITH GOOD FIELD PERFORMANCE



Aggregates for road construction

- sand and gravel;
- aggregate from sedimentary rock;
- aggregate from igneous rock;
- aggregate from steel industry residues;
- different non-conventional aggregates and residues of different sources.
- Last two are known as **artificial aggregates**.





Classification of Construction and Demolition (C&D) waste in large scale

- Steel and metals;
- wood;
- glass;
- plastics;
- rubber;
- bituminous materials and asphalt;
- soil and stones;
- bricks and stoneblocks;
- concrete.





Ordinary use of C&D waste

- Filling or dumping of holes and soft soil in construction areas with crushed concrete, building blocks and stone;
- Using old asphalt in new asphalt mixtures as a added bituminous aggregate;
- Old metals are gathered and used industry by renewing them;
- Old wood is usually burned or composted;








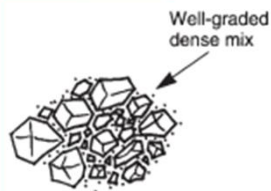
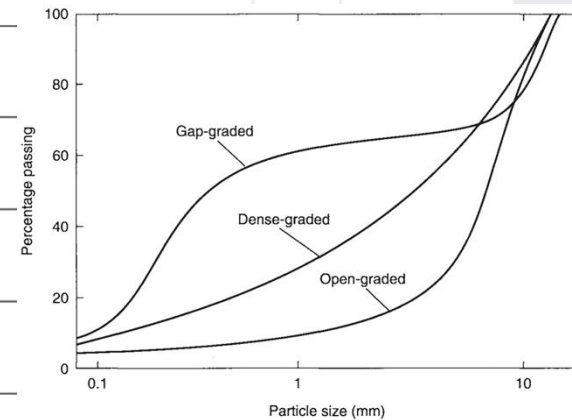
Requirements for aggregates in road base courses: Parameters for describing particle size and shape and distribution

- grain size as **fraction**;
- angularity as **flakiness index** or shape index;
- particle distribution as a **well graded** or **open graded mixture**.



Shape

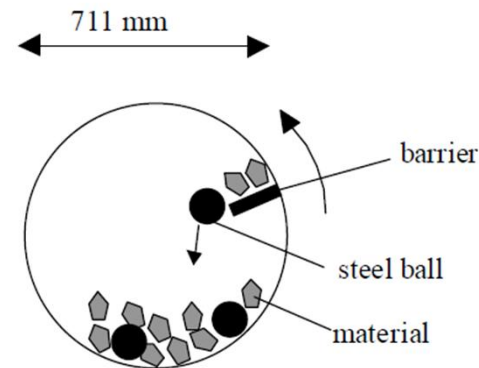
	Rounded Water worn or shaped by attrition
	Irregular Naturally irregular or partly shaped
	Angular Well-defined
	Flaky Thickness is small relative to other two dimensions
	Elongated Length is larger relative to other two dimensions





Requirements for aggregates in road base courses: Parameters for describing the durability for vehicle interaction and weather conditions

- toughness as aggregate **crushing value**;
- water immersion as **water susceptibility**;
- frost susceptibility as **crushing value after freezing-thawing cycles**.



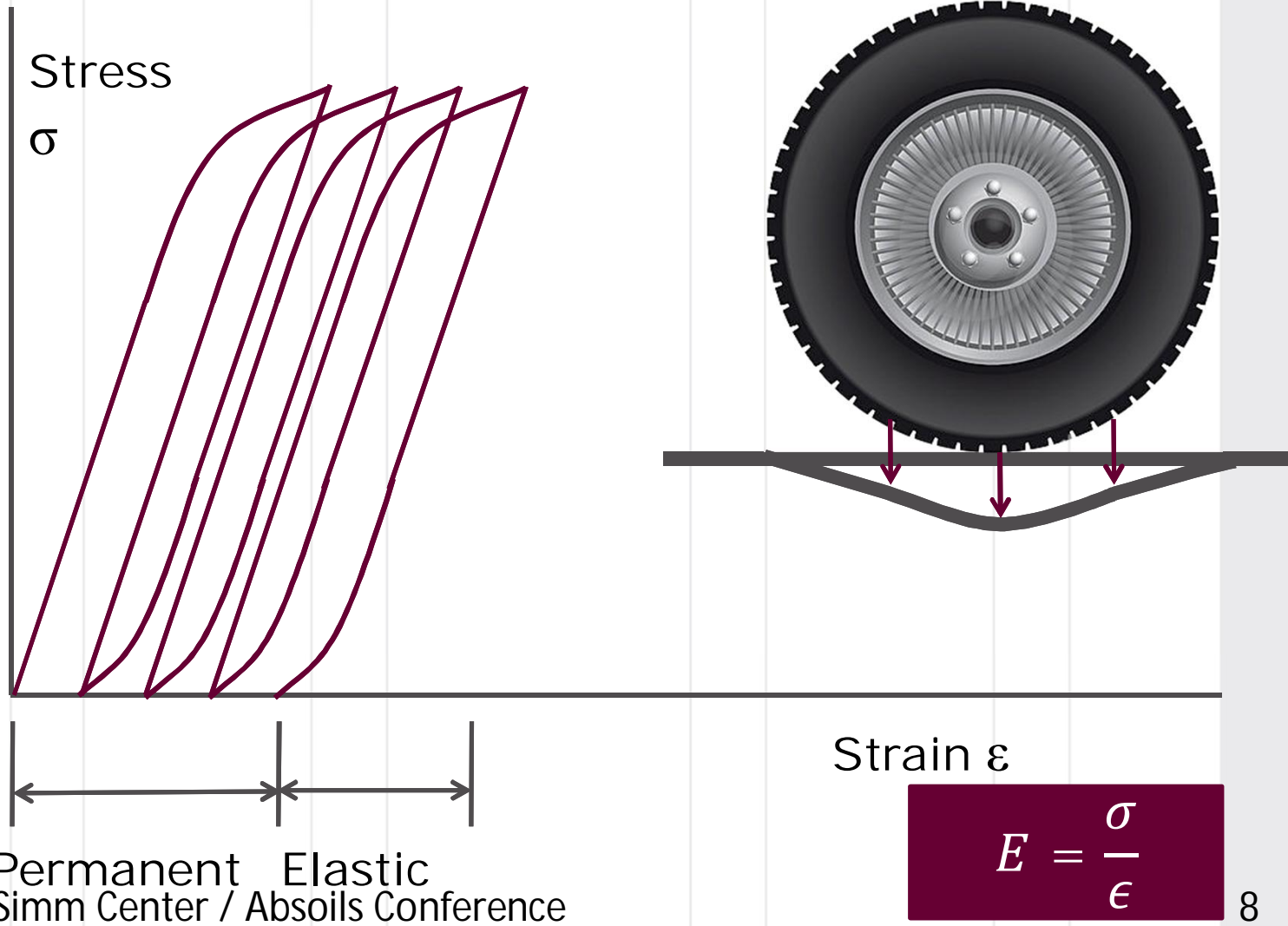


Crushing value of aggregate used in concrete and crushing value of RCA after concrete demolishing

Crushing value of natural aggregate	Stiffness of Concrete (MPa, 28 days)	Crushing value of RCA
Diabase (15,8)	28,6	42
	46,1	38
	74,7	34
Granite (19,5)	29,5	43
	48,6	38
	72,6	32
Gneiss (29,9)	29,0	47
	46,3	41
	71,8	36



Vehicle interaction and bearing capacity of the road





Performance indicators of road pavements

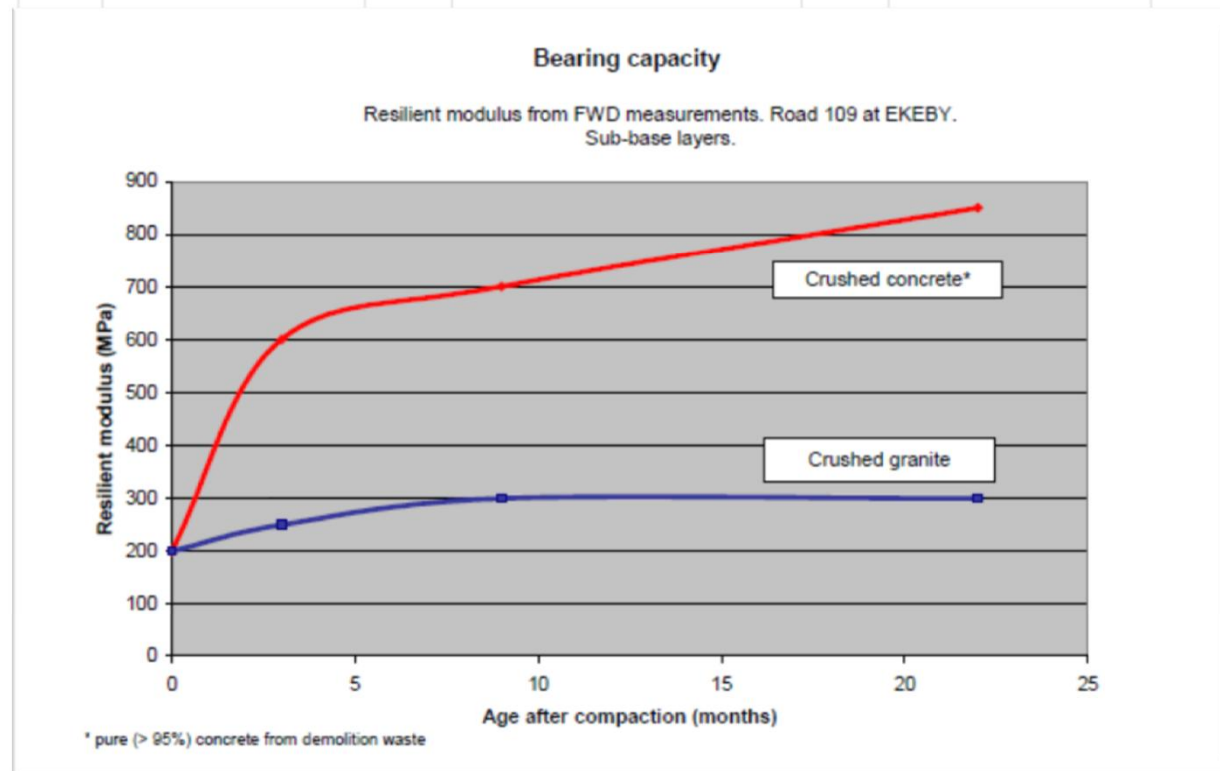
- bearing capacity of road structure (pavement) - measurable parameter elastic modulus of pavement structure (equivalent E-modulus) or E-moduli of separate layers (E_{ac} ; E_{bc} ; E_{sb} ; E_{sg});
- roughness (smoothness) of road surface - measurable parameter IRI, longitudinal unevenness under measuring rod;
- rutting in wheel tracks - measurable parameter is rut depth or transversal profile





High bearing capacity of crushed concrete layer

Swedish test section in ALT-MAT project on 1997.

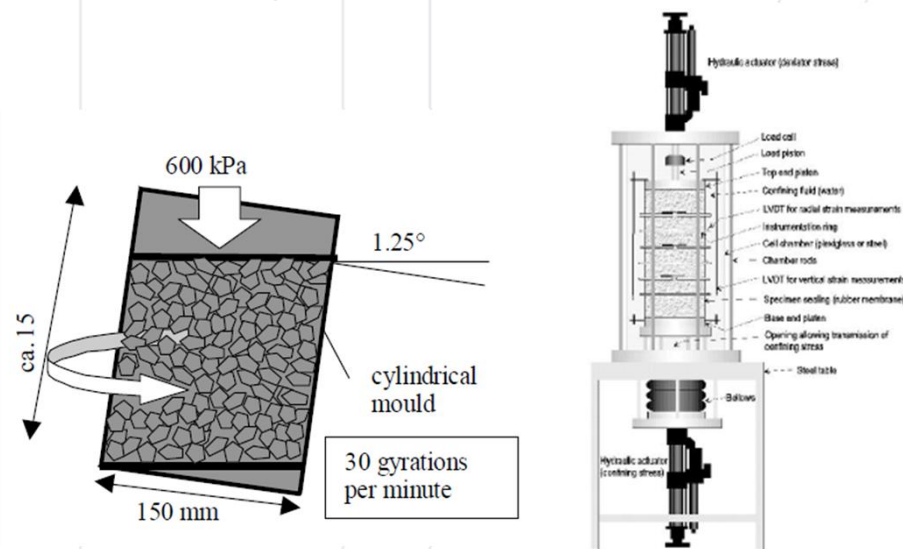




Performance based tests in LAB

Gyratory compaction and 3-axial compression

- Other performance based methods used in ALT-MAT project were gyratory compaction and triaxial testing.
- RCA triaxial testing done also in NTNU for The Norwegian Roads Recycling R&D Program 2002-2005.



Starting point

C&D waste – Why not used in construction courses Estonia so far?



Used only in small private projects not allowed to use on road construction sites.

General opinion: „If it is waste then it can not be material!“

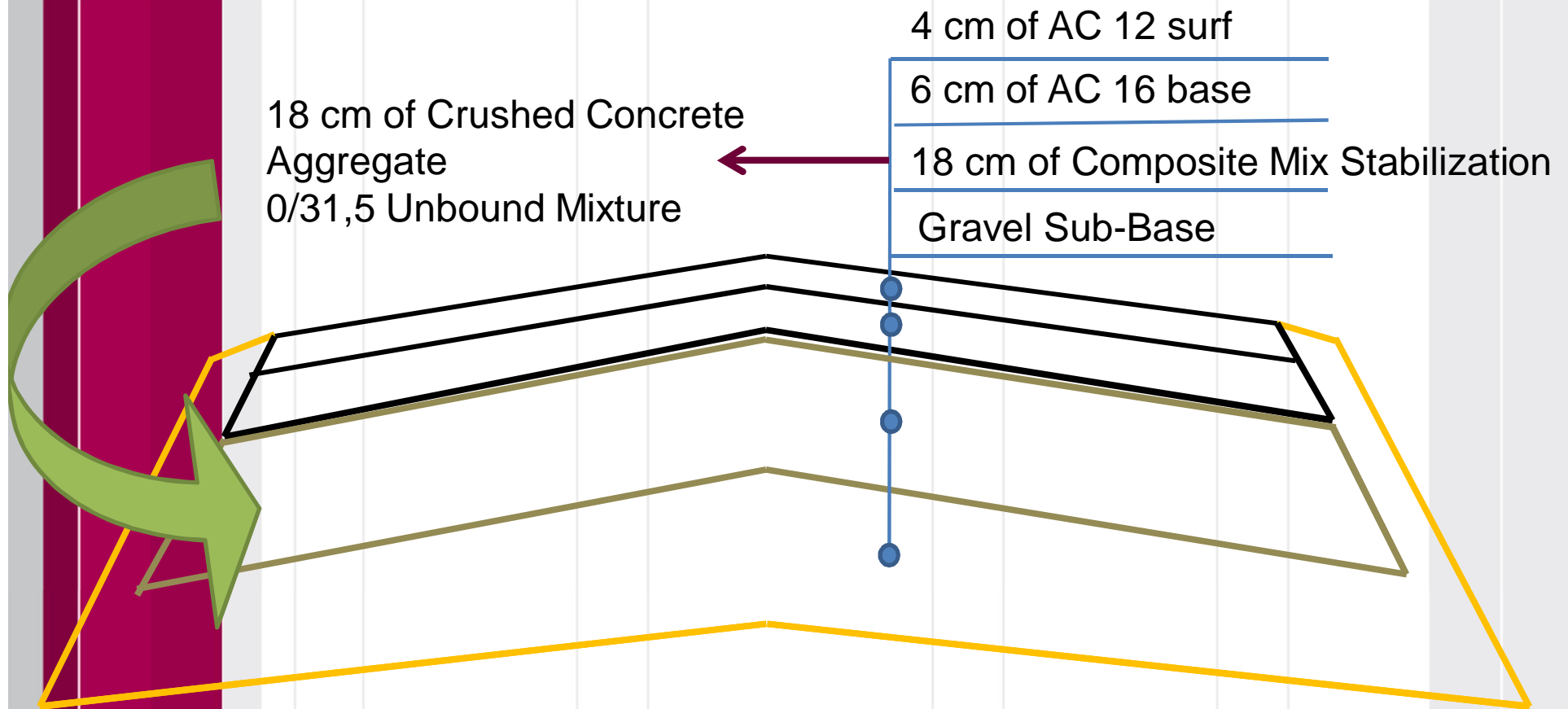
In guidelines RCA was mentioned but not in details.

Requirements in guidelines are 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 road authority we needed our own test section!

Road Pavement before and after replacement with RCA





Material Quality Control on Pilot-section

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

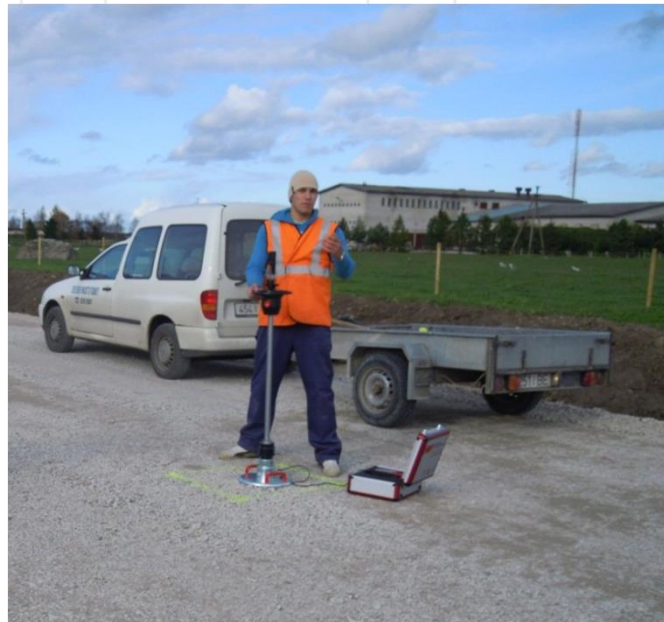
(Estonian device)

German Dynamic Plate (HMP LFG)



Bearing Capacity Measurements with portable Devices and Falling Weight Deflectometer

German DP
(HMP-LFG)



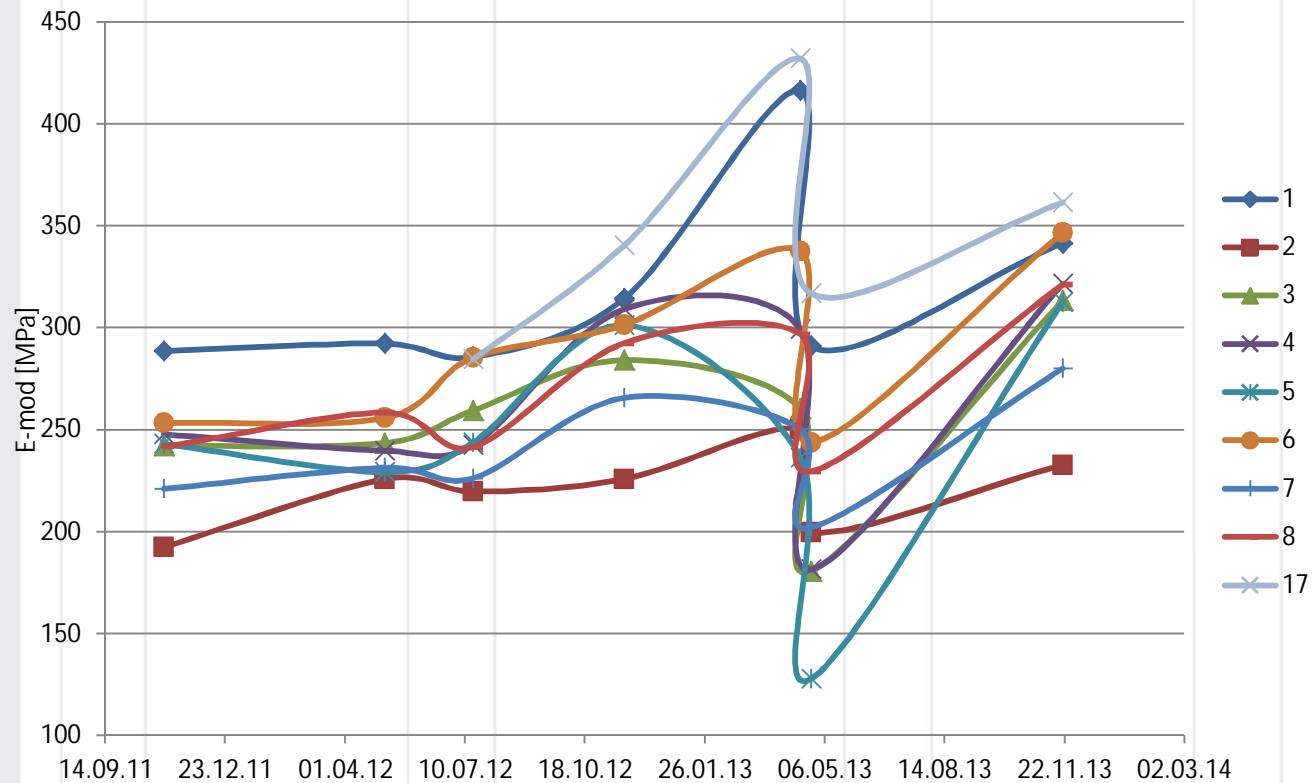
German DP
(HMP-LFG)





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

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



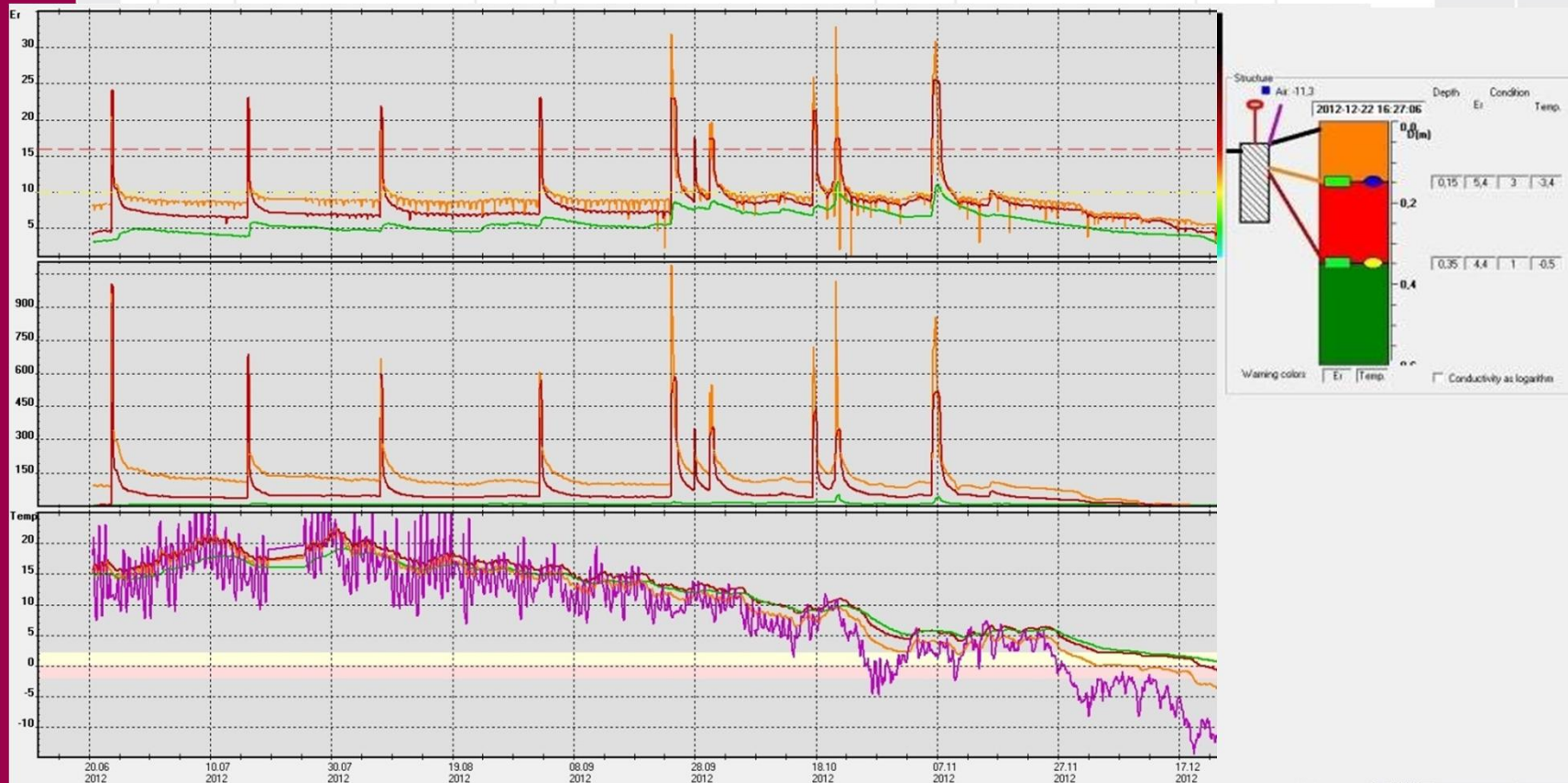


Monitoring of water content in base course layers by dielectric conductivity measuring station



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

Percostation measurements on the period from installation until the end of year 2012





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.

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.



Certification for crushed concrete aggregate different fractions

VAHTER HENDRIKSON
INSENERIBÜROO ENGINEERING COMPANY V-P08/1

EC TOOTMISOHJE SERTIFIKAAT
2325-CPD-0038

Kooskõlas EÜ Nõukogu direktiiviga 89/106/EMÜ 21.detsembrist 1988.a liikmesriikide ehitustooted käsitlevate seaduste, määruste ja haldusnormide ühtlustamisest (ehitustooted direktiiv e CPD) koos hilisema muudatusega, on kindlaks tehtud, et ehitustoode

taaskasutatav täitematerjal, purustatud raudbetoon
fraktsioonid: 0/16, 0/32, 0/63, 16/32, 32/63

kasutamiseks vastavalt:
EVS-EN 13242:2006+A1:2008, hüdrauliliselt seotud ja sidumata kihtide täitematerjalina,

mille on turule toonud
ATI Grupp OÜ
registrikood 10508923, Peterburi tee 94, 11415 Tallinn

ja tootnud
Kiilumeister OÜ,
registrikood 12187601, Peterburi tee 94, 11415 Tallinn,
ehitusjäätmete käitluspaigas Vao karjääris,

on läbinud tootjapoolsed algsed tüübikatsed, allub tehase tootmisohjele ja tootja katsetab toodet perioodiliselt vastavalt kehtestatud katseskeemile.
Tunnustatud asutus nr 2325 - Inseneribüroo Vahter & Hendrikson on teostanud tehase esmasse ülevaatuse ja tootmisohje kontrolli ning jätkuvalt jälgib, hindab ja tunnustab tehase tootmisohjet. Sertifikaat tõendab, et kõik standardi

EVS-EN 13242:2006+A1:2008

lisas ZA sätestatud tehase tootmisohje sertifitseerimise tingimused on täidetud.

Sertifikaat väljastati esmakordselt 19.06.2012 ja kehtib kuni ei ole oluliselt muudetud viidatud harmoneeritud standardi tingimusi või tootmistingimusi või tehase tootmisohje süsteemi, kuid mitte kauem kui 19.06.2015.

Tallinn, 19.06.2012

Peeter Vahter
Peaekspert


Inseneribüroo Vahter & Hendrikson OÜ
Raua 49, 10152 Tallinn, Eesti / Estonia
13.9.94

TAASKASUTATAVA TÄITEMATERJALI VASTAVUSDEKLARATSIOON NR 1

CE 2325						
Turule tooja: ATI Grupp OÜ, Peterburi tee 94, Tallinn 11415 Tootja: Kiilumeister OÜ, Peterburi tee 94, Tallinn 11415 Tootmiskoht: ehitusjäätmete käitluspaik, Vao karjäär, Tallinn 12 2325 - CPD - 0038 EVS-EN 13242:2006+A1:2008 Ehitustöödel ja tee-ehituses kasutatavad sidumata ja hüdrauliliselt seotud täitematerjalid						
Tüüp	Määratlus	Taaskasutatav täitematerjal, purustatud raudbetoon				
Tera suurus	Määratlus	0/16	0/32	0/63	16/32	32/63
Terastikuline koostis	Kategooria	G _A 85	G _A 85	G _A 85	G _C 80-20	G _C 80-20
Terastikuline koostis sõela läbindi massiprotsendina						
80 mm	Dekl. väärts			100	100	100
63 mm				85...100	100	85...99
40 mm				85...99	40...80	98...100
31,5 mm				100	40...80	80...100
20 mm				100	40...80	35...65
16 mm				85...100	40...80	0...20
12,5 mm				60...90	10...30	0...5
8 mm				60...90	10...30	0...5
6,3 mm				40...70	5...25	
4 mm				40...70	0...15	
2 mm				30...60	0...10	
1 mm				20...50	0...3	0...4
0,063 mm				0...9	0...3	0...4
Kesksõela piirhälbed	Kategooria	GT _A 25	GT _A 20	GT _A 20	GT _C 20/15	GT _C 20/15
Plaatsustegur	Kategooria	FL ₂₀	FL ₂₀	FL ₂₀	FL ₂₀	FL ₂₀
Peenosiste sisaldus	Kategooria	f ₀	f ₁	f ₁	f ₄	f ₄
Koostisosad	Kategooria	Rcug 90 Rb 10- Ra 5- FL 5-				
Purunemis- kindlus fr 10/14	Kategooria	LA ₁₀				

Tootmiskoht: ehitusjäätmete käitluspaik Vao karjääris
Kvaliteedispektant: Jana Raid

Allkiri:  29.märts 2012.a.



THANK YOU FOR YOUR KIND
ATTENTION!

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