VÄYLÄ

Experience of Finnish system (PANK) for quality verification by using GPR

Katri Eskola (FTIA),
Eeva Huuskonen-Snicker (Destia)

2.4.2019

Contents

- Background / History
- Summary of the method (PANK – 4122)
  - FTIA requirements for measurements
- Research project 2013-2017 in Finland
  - Main questions and findings
- GPR test section and annual tests in Finland

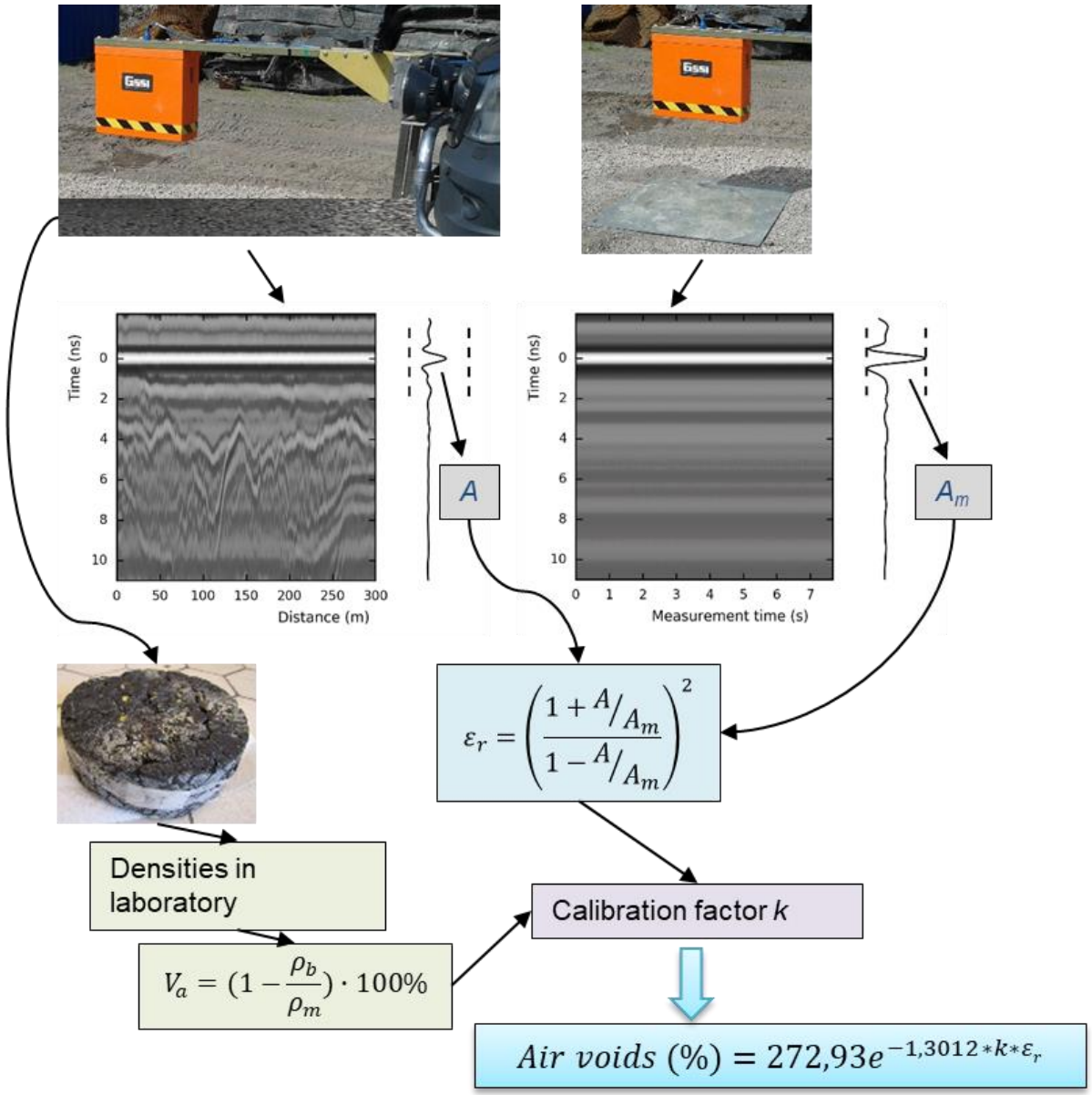
Asphalt pavement quality verification with GPR in Finland - History

VÄYLÄ

- Based on Roimela's studies 1996-1997 and 1998
  - http://www.doria.fi/handle/10024/138831
  - http://www.doria.fi/handle/10024/138885
- First method description (PANK-4122) was published 26.10.1999
- The method was introduced to:
  - Asphalt maintenance contracts since 2000 and
  - Finnish Asphalt specifications 2000
- Based on experiences PANK-4122 was updated 6.5.2004 and 9.5.2008:
  - http://pank.fi/tekniset-vaatimukset/pank-menetelmat/pank-4-asfalttimassat
- The method has been used for quality control of new asphalt pavements

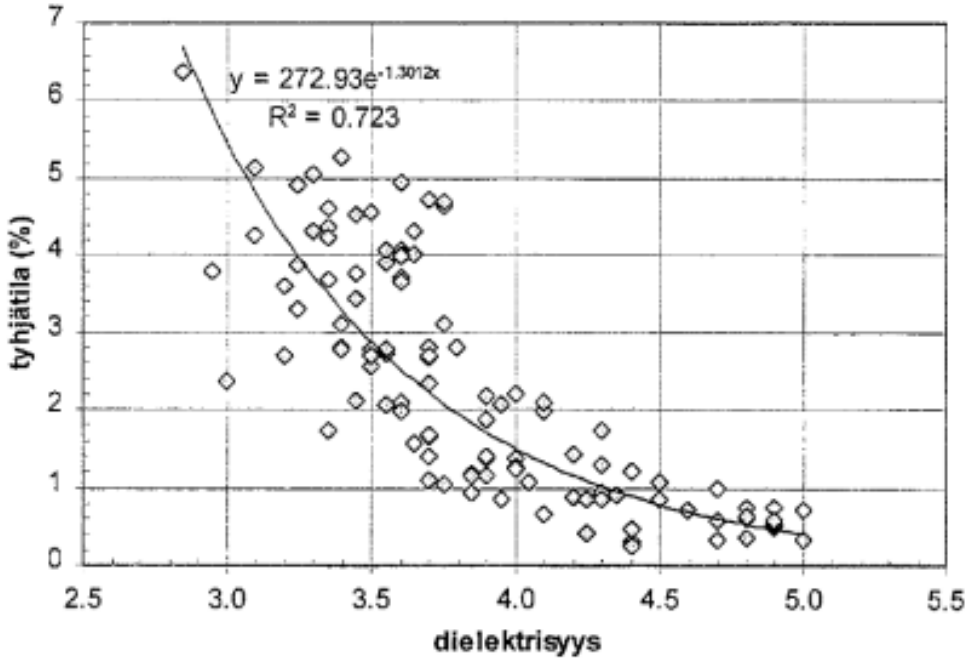
The principle of air void content measurements according to PANK-4122

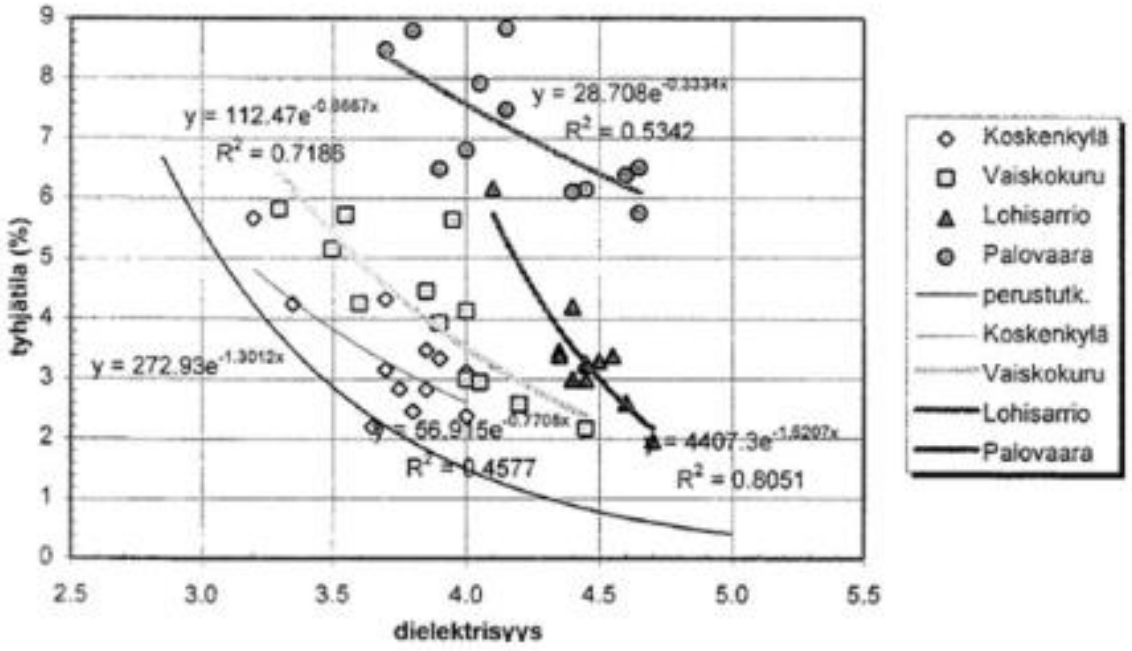
- 1 GHz
- 10 scan/m



(Huuskonen-Snicker (2017) http://urn.fi/URN:ISBN:978-952-60-7228-9)

An exponential correlation for permittivity and air voids (%) was found based on the laboratory studies in 1990's





Additional requirements to PANK – 4122 by FTIA

- Some detailed instructions are given by FTIA (last update in 2019):
  - https://julkaisut.vayla.fi/pdf11/vo_2019-01_uusien_paallysteiden_web.pdf
  - Measuments within 2 - 21 days (rather before rain)
  - Metal plate calibration before and after the site is measured
  - Right wheel path
  - 2 core samples are taken / 10 lane-km
  - Density of core samples is measured in laboratory:
    - By DRY method when AC for surface and binder courses
    - By SSD (and sealed by film) when SMA
  - Reference test section measurement is required annually

Benefits of the Finnish system

- Continuous and fast measurements from a vehicle
  - No or little disturbance to traffic
  - Work safety
- Only few drilled samples, few holes in the new pavement
- ”Common practice” in Finland
  - Many companies and GPR systems available for measurements

Challenges to the Finnish system

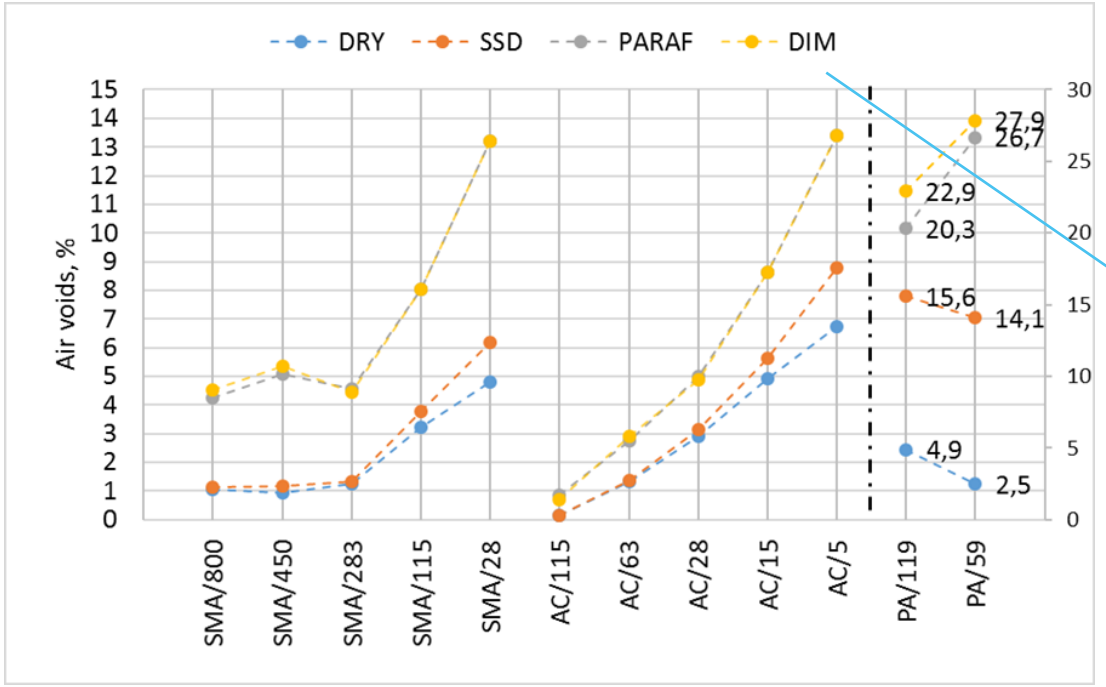
- **Thin layers**
- **Hot-in-place Recycling / recycling of materials**
- **Rain / water**

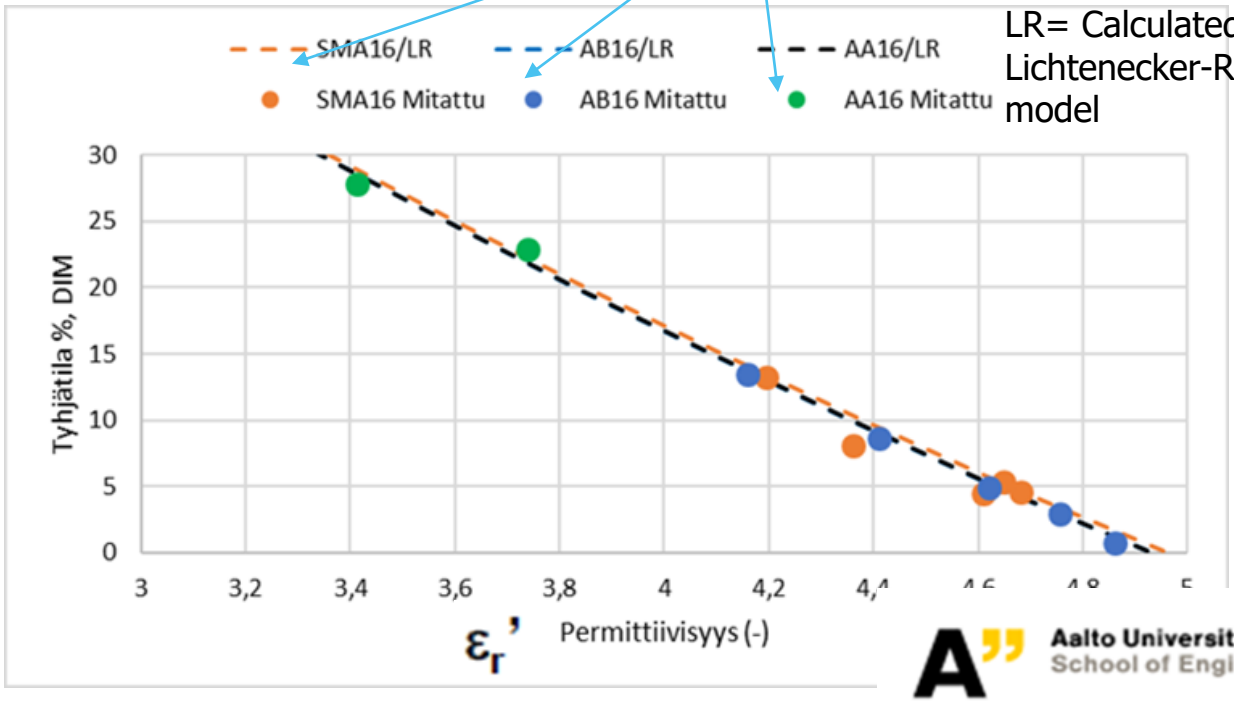
- The PANK method applied in Finland was studied in a research project funded by FTIA in 2013-2017
- Main research questions:
  - Is the currently applied GPR method reliable and valid in QC of thin overlays?
  - Is there a need to update the PANK method description?
- More information and a list of publications can be found from:
  - https://openlearning.aalto.fi/course/view.php?id=31&section=3

Aalto University
School of Engineering

Assessment of Asphalt pavement density: Correlation in laboratory made samples when…

- No variation of aggregate's permittivity ε_r'
- Void content measured by dimensions (DIM/Parafilm)
- Density ρ_p and permittivity ε_r' is measured from core samples
- No water in a sample



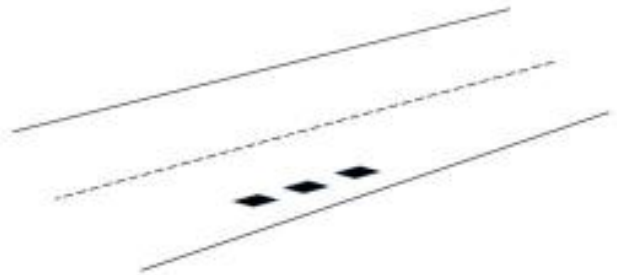


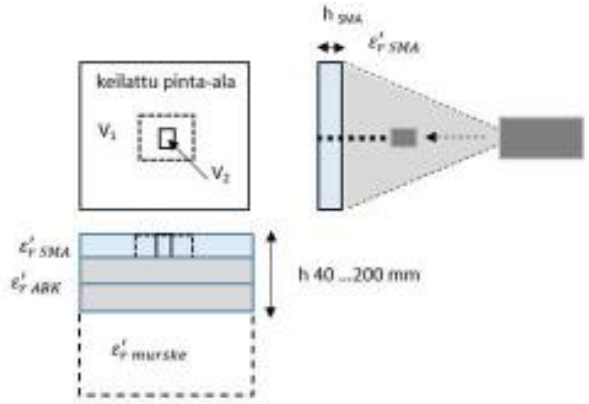
LR= Calculated by Lichtenecker-Rother-model

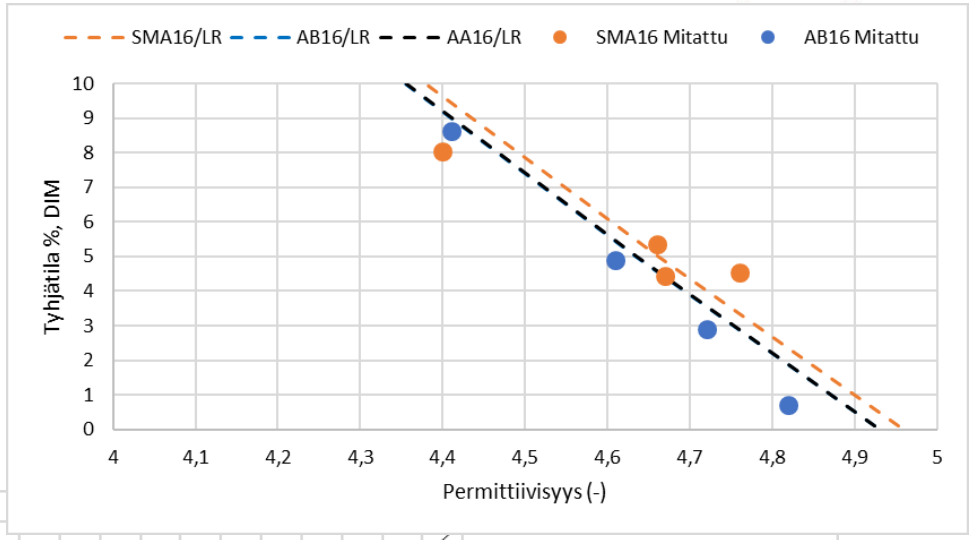
Aalto University
School of Engineering

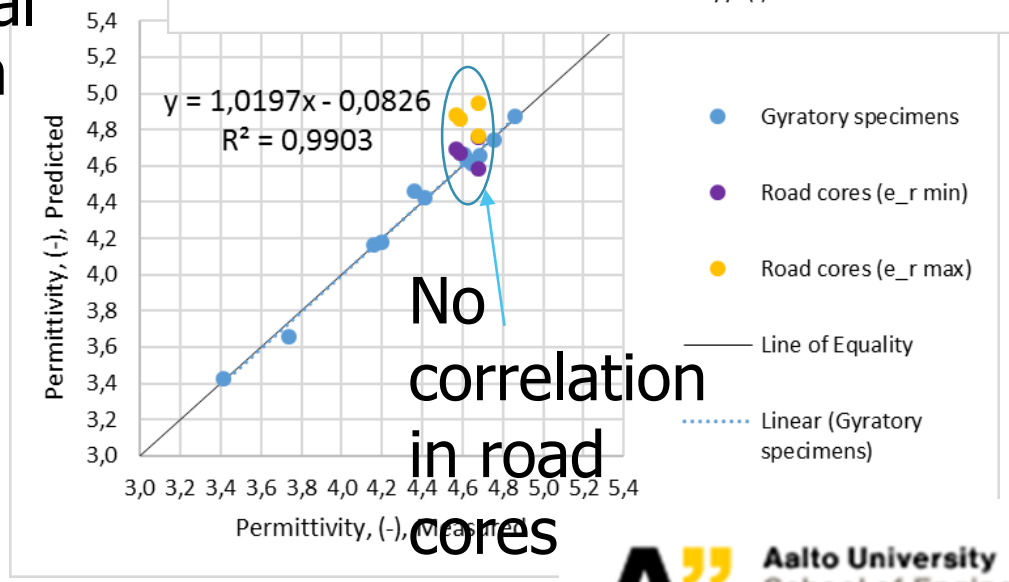
Assessment of Asphalt pavement density: Measurements on road by GPR

- Aggregate's variation is included ε_r'
- Changes in volumetric properties changes void content but is not seen in the asphalt's ε_r'
- Water is affecting measurement results
- Representative volume element is not equal in GPR and core sample used in calibration







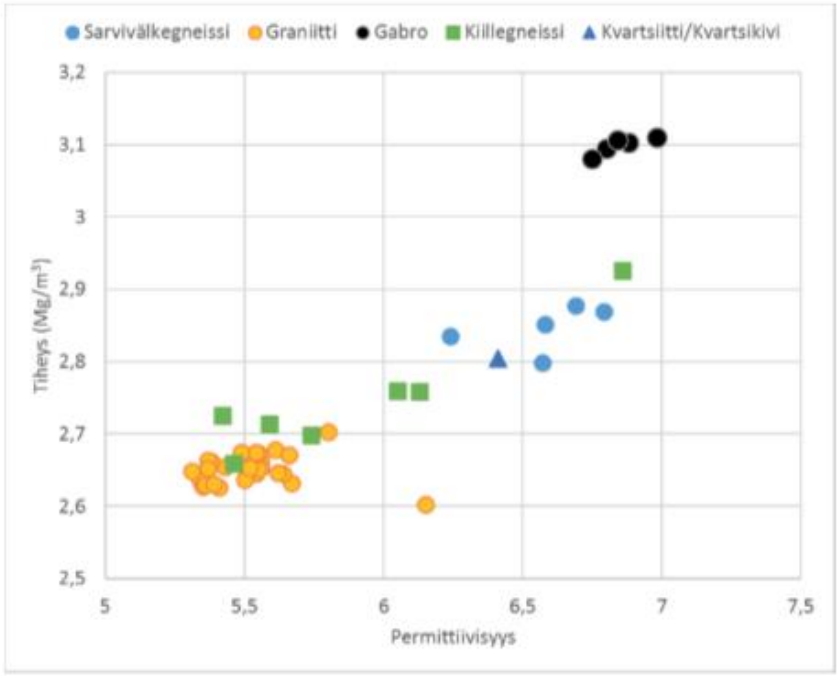


Aalto University
School of Engineering

When material variation is taken into account

Relative permittivity vs. Density

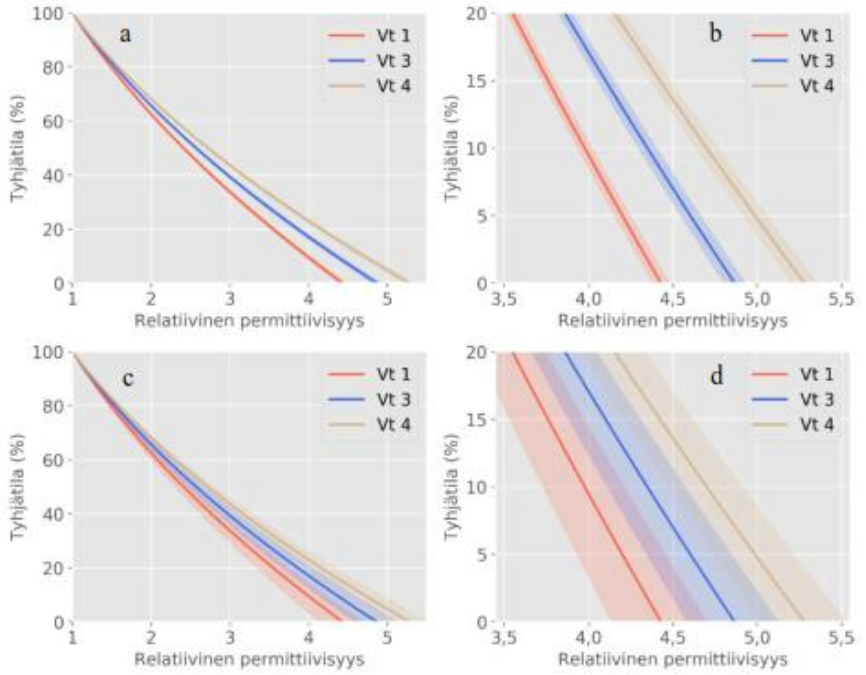
Permittivity properties of different rock types



Relative permittivity vs. Air voids (%)

CRIM model

Bitumen content ± 1 %



Variation of rocks ± 0.2

(Pellinen et. al (2018) http://urn.fi/URN:ISBN:978-952-60-7825-0)

GPR test section and annual tests in Finland

- Annual comparison tests of GPR systems are required by FTIA
- A test section was especially designed for GPR testing and built in 2017 near Tampere in Finland
- The test section is constructed of slabs of varying materials with different dielectric properties and thicknesses (30-150 mm)

DESTIA
BUILDING THE BIGGER PICTURE

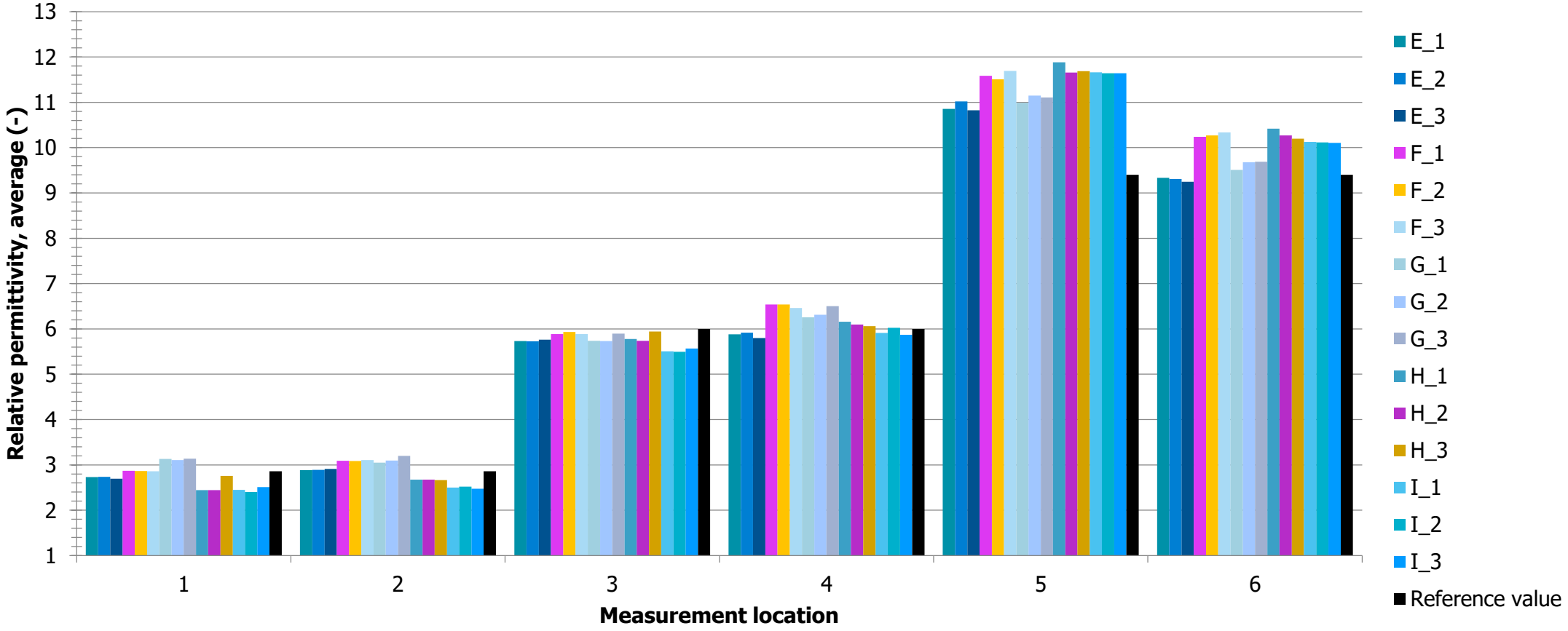
Test section measurements

- 3 test measurements with slow speed + 1 measurement on a marked spot + 1 metal reflection measurement
- 20 scans/m
- Raw data files delivered to Destia for analysis

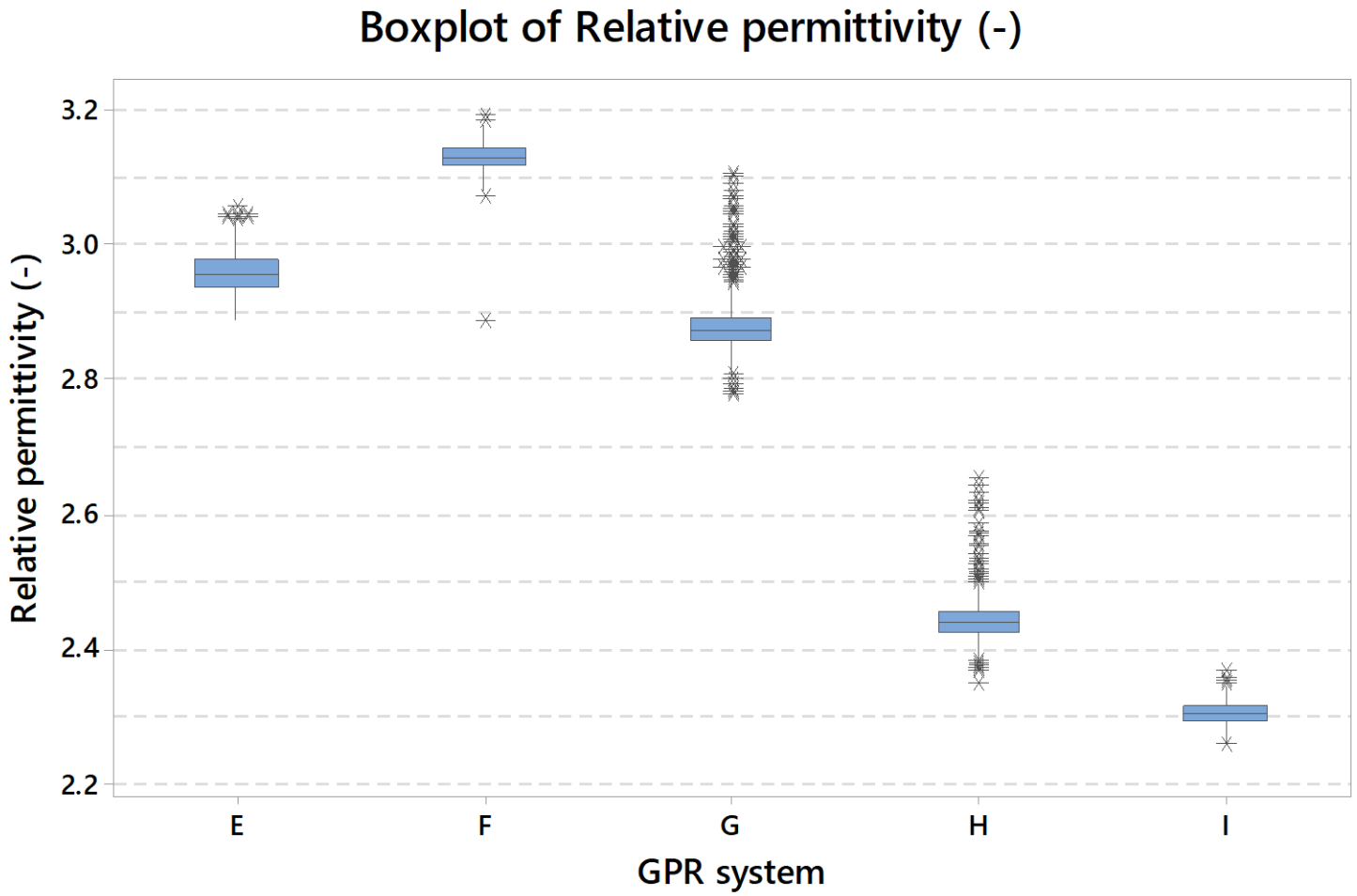
➢ Analysis of results compared to reference values

➢ Repeatability and reproducibility of GPR measurements can be analyzed

Test section results from 2018
(5 GPR systems tested)

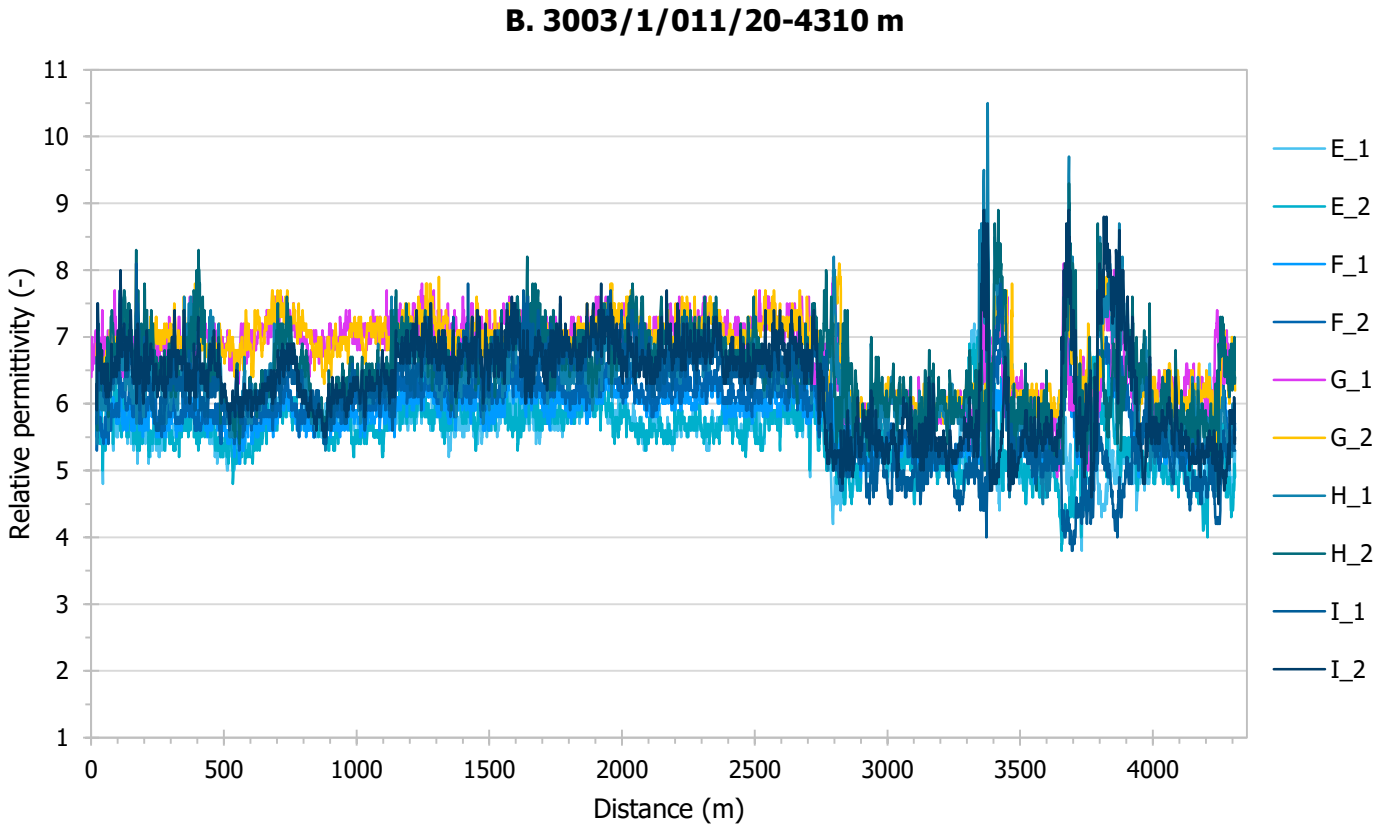


Time based measurement results over a homogenous (150 mm) slab

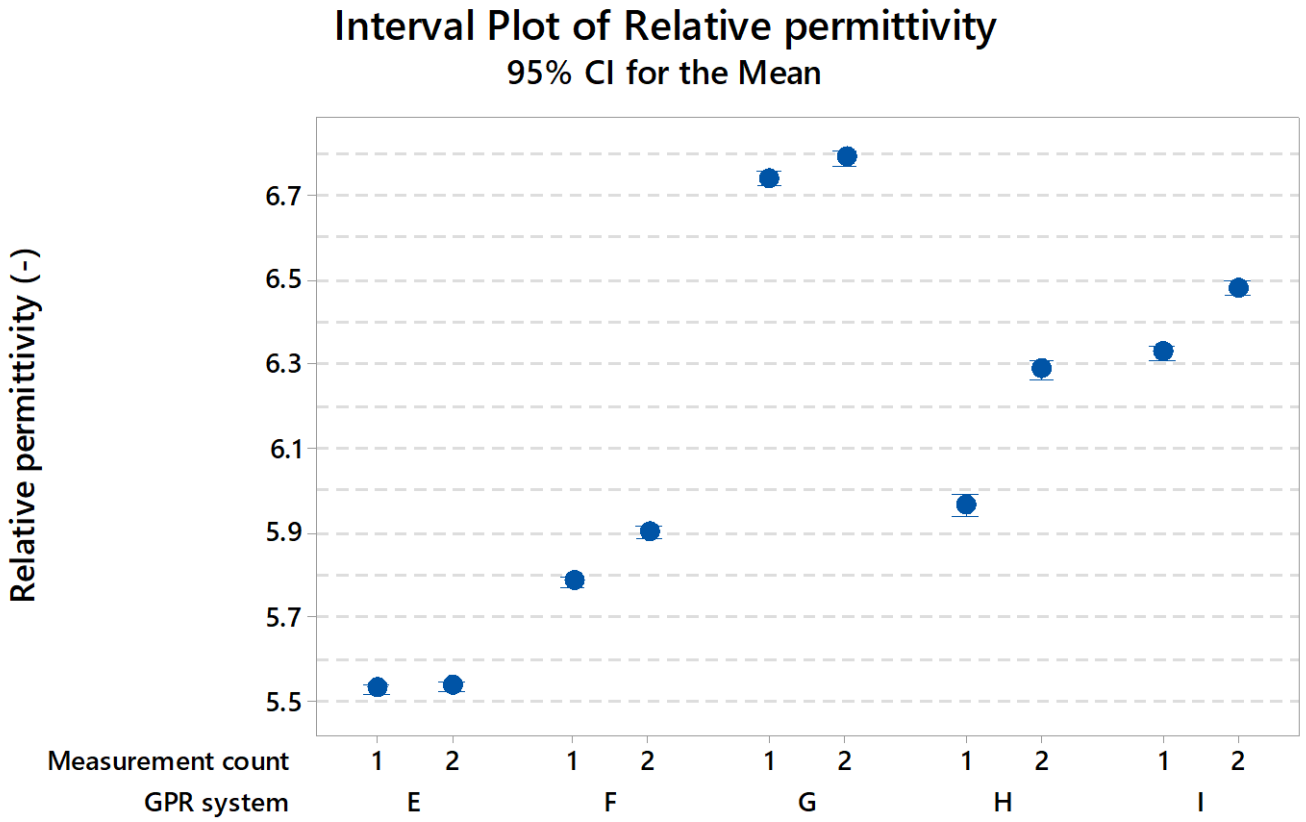


Road section results

- In addition to measurements of the test section, a road section was measured with different GPR devices 2 times.
- 10 scans/m
- 1 m average results
- 5 different GPR systems



Comparing permittivity differences from a road section with respect to PANK method



Individual standard deviations are used to calculate the intervals.

- Relative permittivity -> air voids with different calibration factor k

ε_r (-)	V_a (%), k=1	V_a (%), k=0.8	V_a (%), k=0.6	V_a (%), k=0.4
5.5	0.2	0.9	3.7	15.6
6.0	0.1	0.5	2.5	12.0
6.5	0.1	0.3	1.7	9.3

➢ One unit difference in relative permittivity can mean 2 % difference in air voids

Summary

- The Finnish PANK method has been applied for quality verification of new pavements in Finland since 2000
- Some new requirements for the method based on the recent research
  - Still a need to improve the method / solve some problems
- Annual testing of GPR systems is carried out in Finland to improve the quality of GPR measurements
  - How to reduce variation of GPR results?

Future challenges for quality verification in Finland

- Measurements from the entire lane width
  - Not just a wheel path
- Towards controlling the paving process, rather than quality verification afterwards

Thank you!

Further information:

katri.eskola@väylä.fi

eeva.huuskonen-snicker@destia.fi


VÄYLÄ