

# Swedish GPR experiences

Gustav Tennby  
[Gustav.tennby@trafikverket.se](mailto:Gustav.tennby@trafikverket.se)



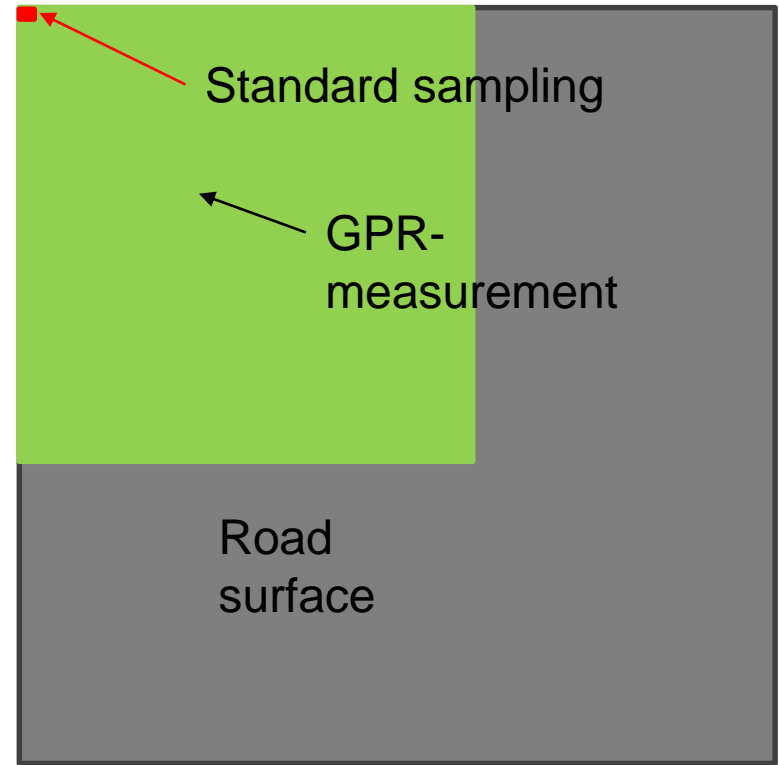
**TRAFIKVERKET**  
SWEDISH TRANSPORT ADMINISTRATION

# Swedish Transport Administration Experience with GPR

- Started using GPR in 2016
- Part of a bachelor thesis in 2017
- A SBUF project in 2018
- Continuation of project in 2019
  
- Want to evaluate Air Void Content and Homogeneity with the GPR technique

# GPR coverage

- Compared to standard sampling
- GPR = 35%
- Standard sampling = 0,00026%

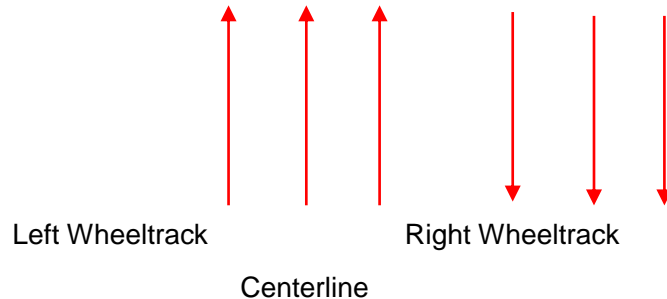


# 2018 in Sweden

- Used GPR on 10 objects of varying asphalt mass
- Evaluated 170 km (106 miles) in total

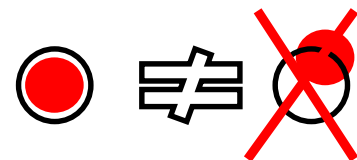
# How are measurements performed?

- We use a 2.5 GHz GPR with 3 channels (Antennas)
- 1 Antenna in each wheeltrack and 1 antenna in between simultaneously
- Calibrate permittivity – Air void content with 6 -10 samples



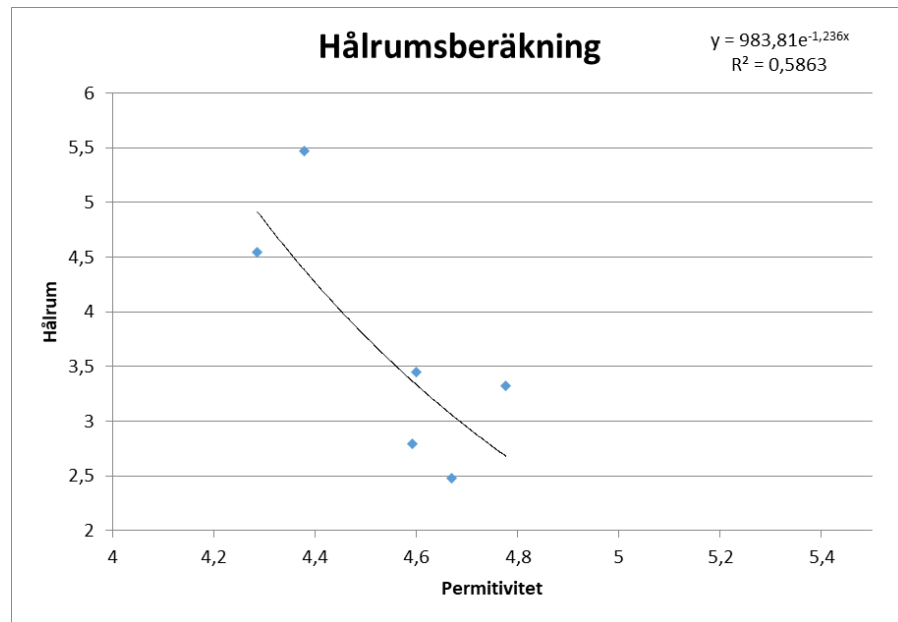
# Sampling method

- Pre-determined points
  - 10 cm diameter samples
- Refined during the project to
  - Samples from the entire permittivity range
  - Permittivity value over atleast 10 cm in asphalt
  - 15 cm diameter samples, positioning!

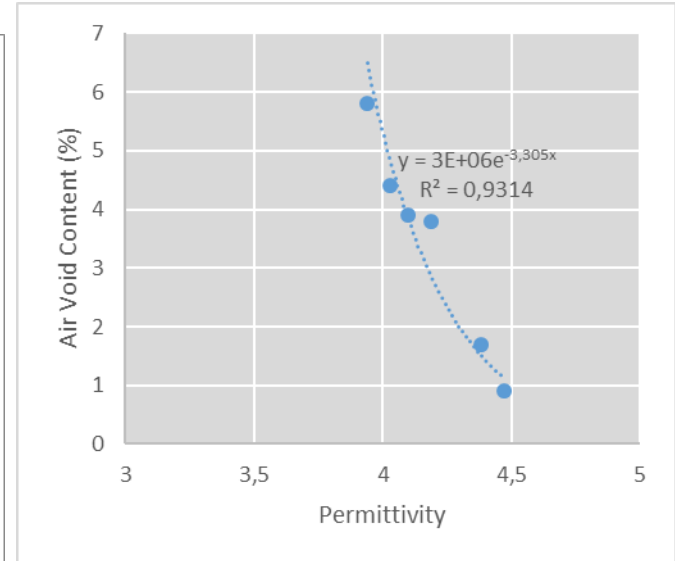
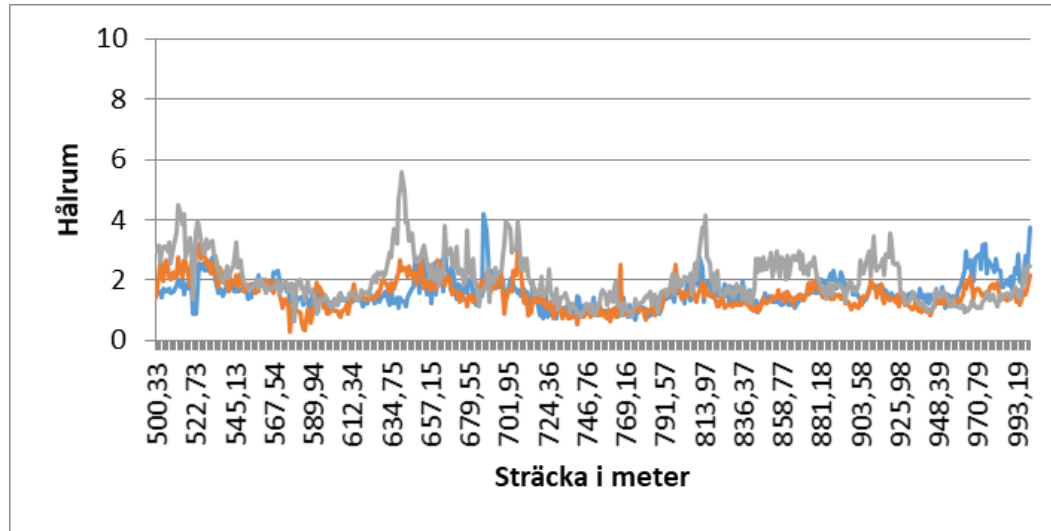


# Non-standard asphaltmix

- Pre-determined sample locations
- Samples from different mass used in calibrating measurement
- Uncertain result



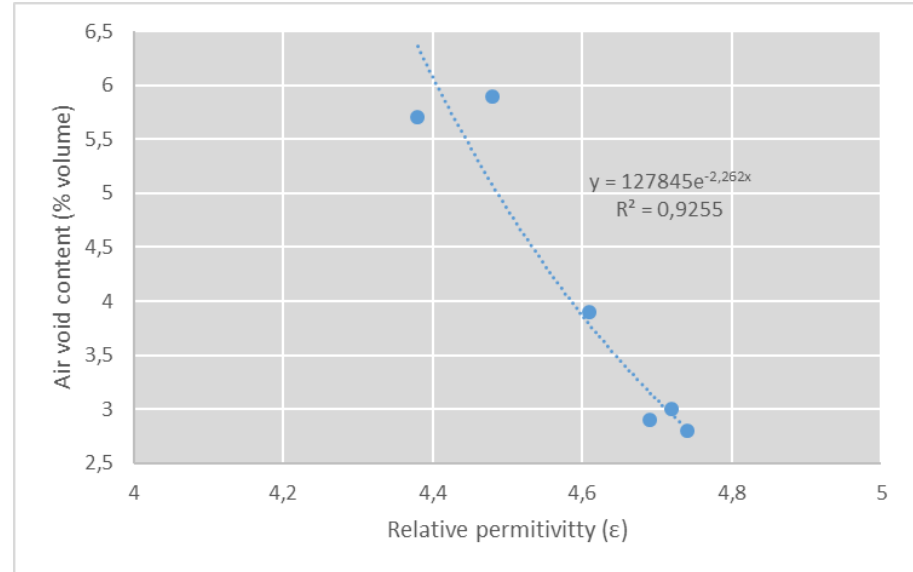
# Objects using Refined sampling method





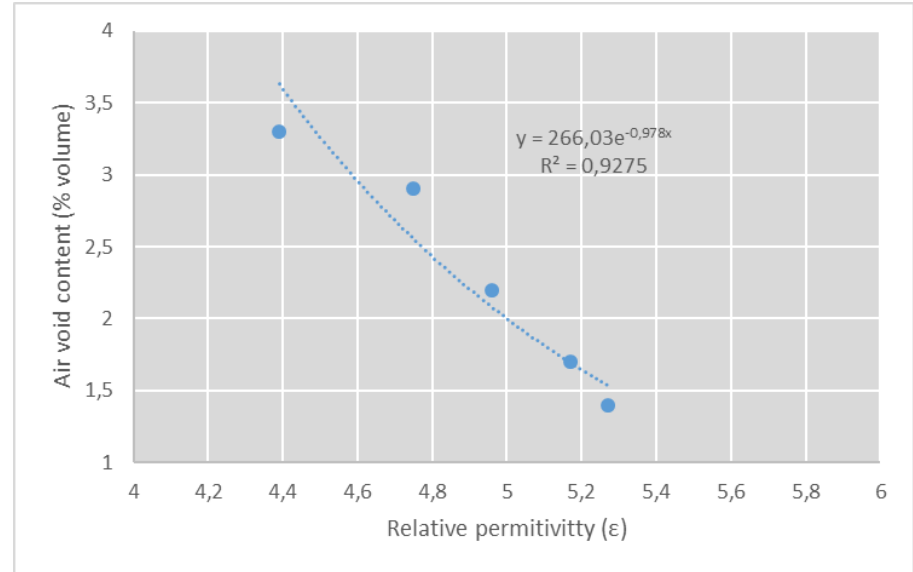
# More examples of Refined sampling method

- Achieved with refined method
- A binder-layer

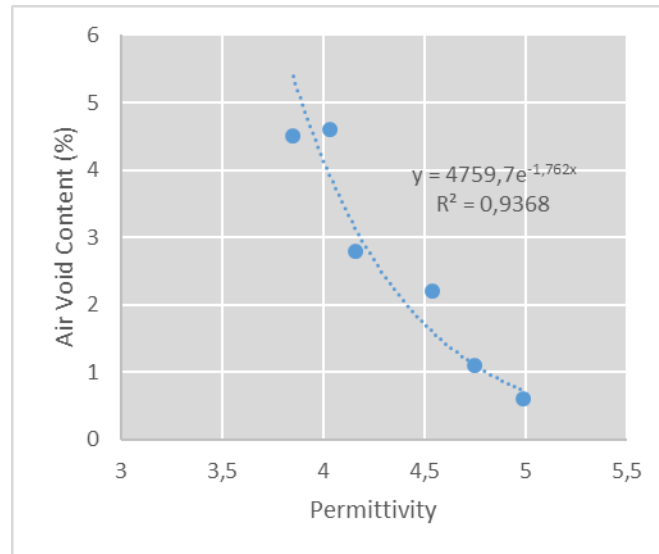
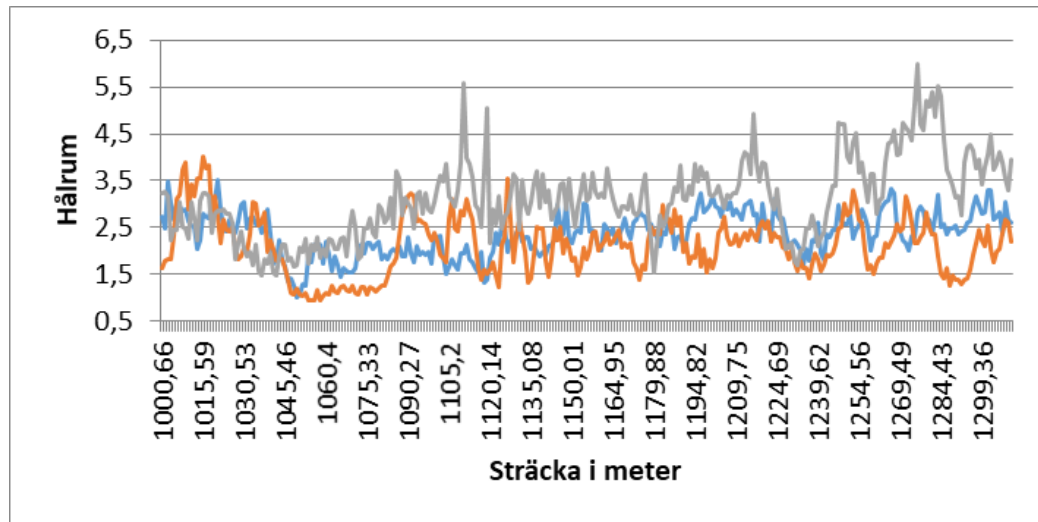


# More examples of Refined sampling method

- A wearing course

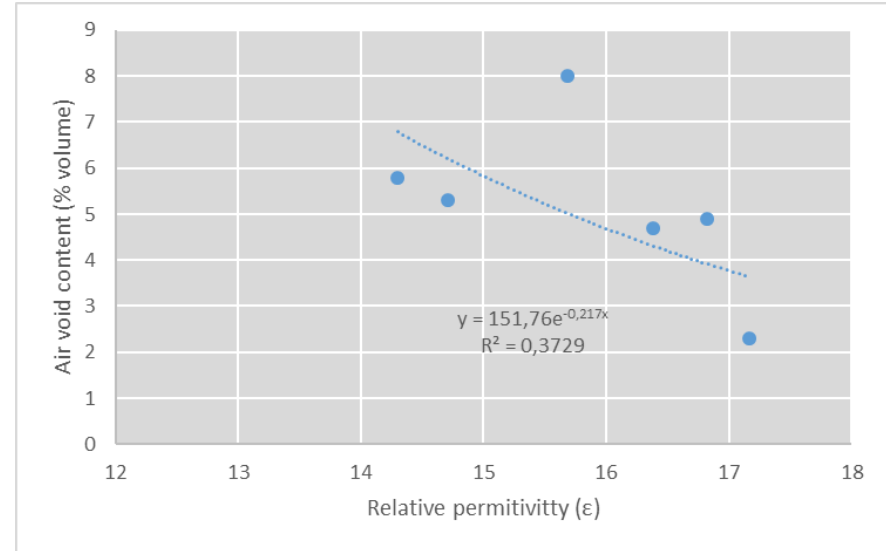


# Remixing measurement



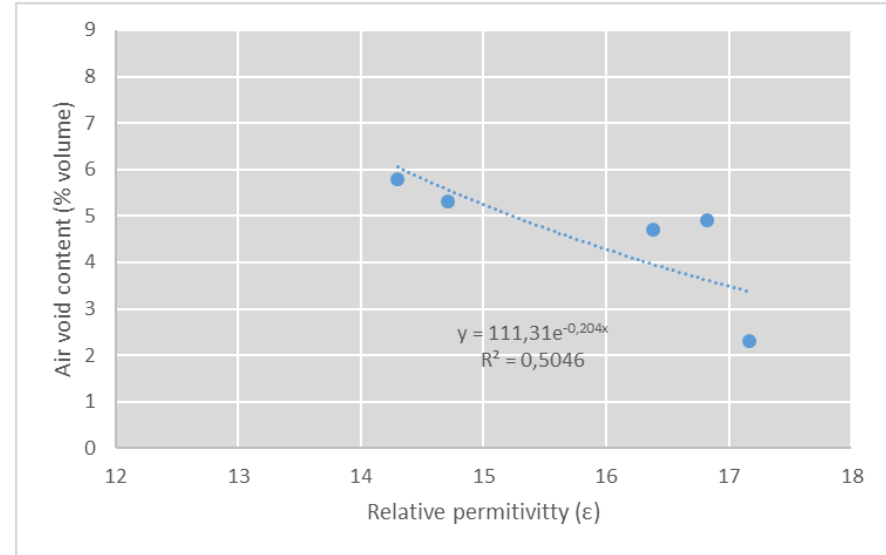
# Slag

- Measurement on slagmix
- A higher relative permittivity than asphalt without slag
- Correlation  $R^2 = 0,37$
- Can be improved, but...
  - $R^2 = 0,50$



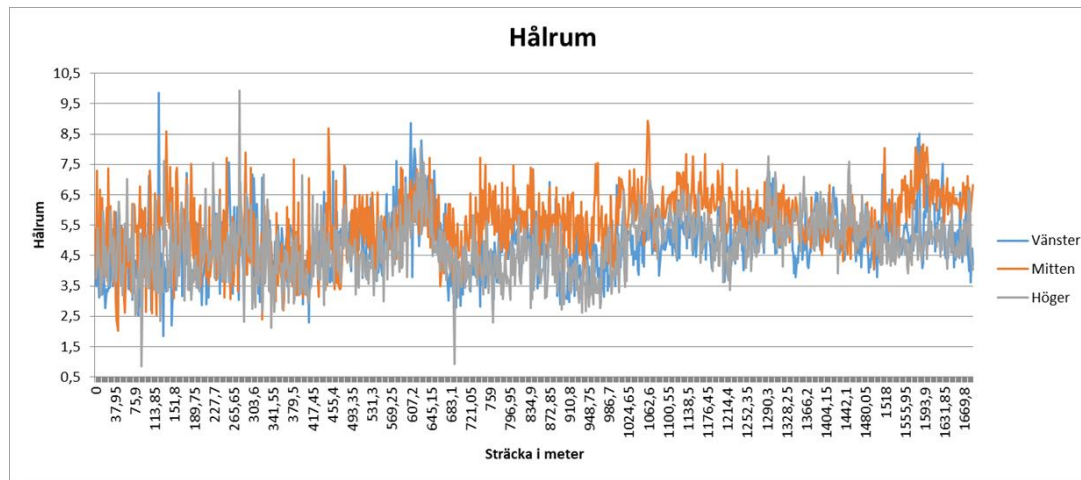
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# Slag

- Results?
- There is potential
  - Further evaluation

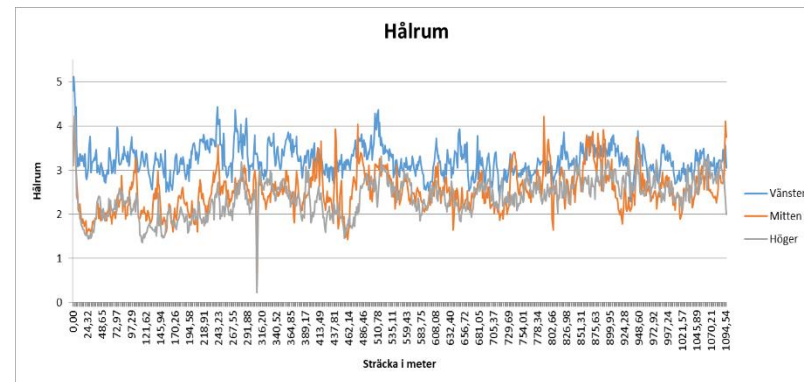


Antenn	Medel	Std.	Varians	$\Delta H$	$\Delta C$	$\Delta V$
Höger #64	4,8	1,0	20,4%	-	1,2	0,9
Center #67	5,5	1,1	19,3%	1,2	-	1,1
Vänster #65	4,9	1,0	20,6%	0,9	1,1	-

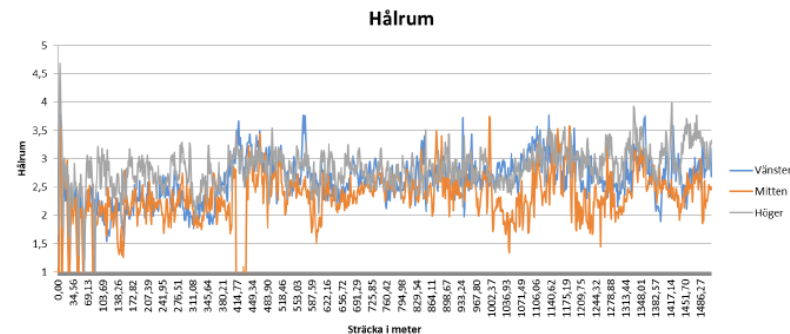
# Choosing equipment

- The effect of choosing production equipment does matter
- Coarser material to the sides
- Results of not mixing asphalt

Without

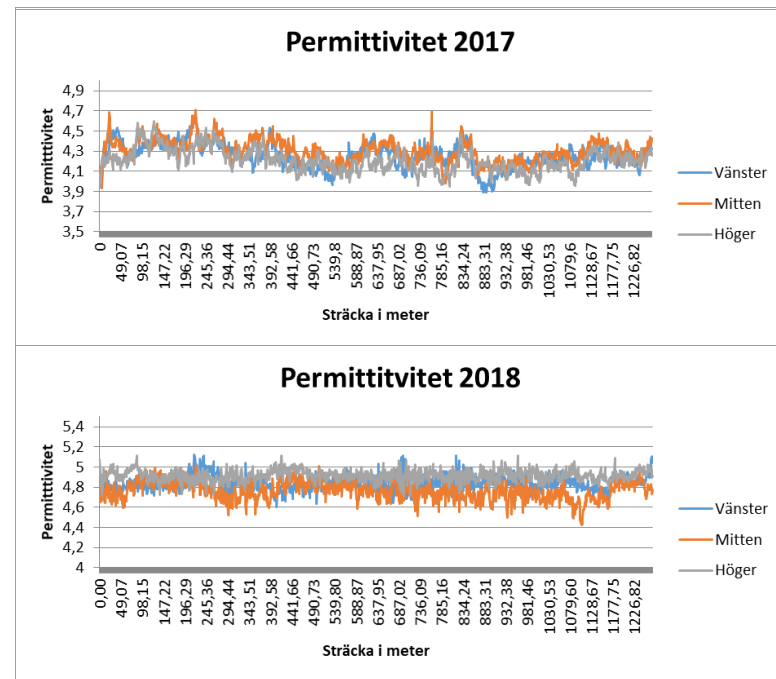


With



# Timing the measurement

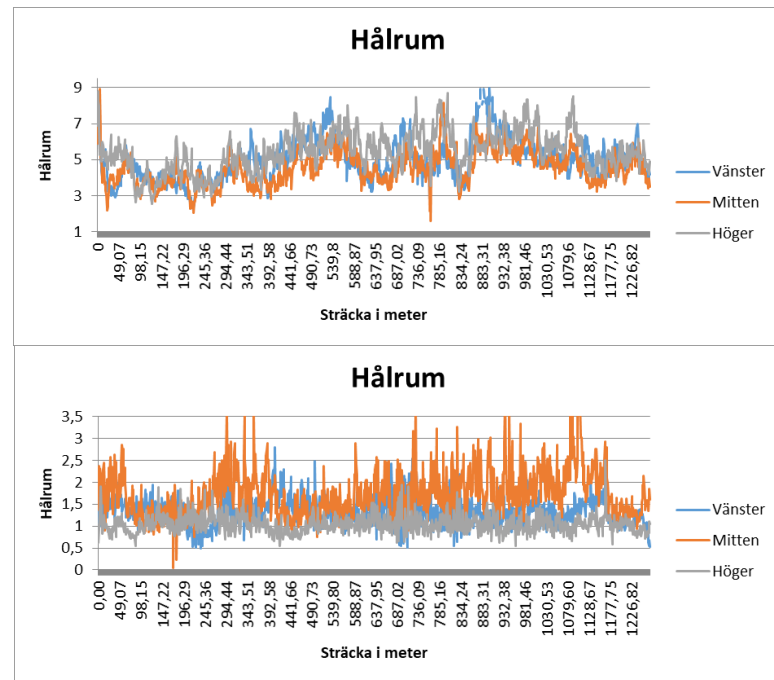
- The measurements has to be planned
- Possible adjustments for the rollers
- Dry conditions - water/wet asphalt influence the results
- No effect/Reduce trafic compaction





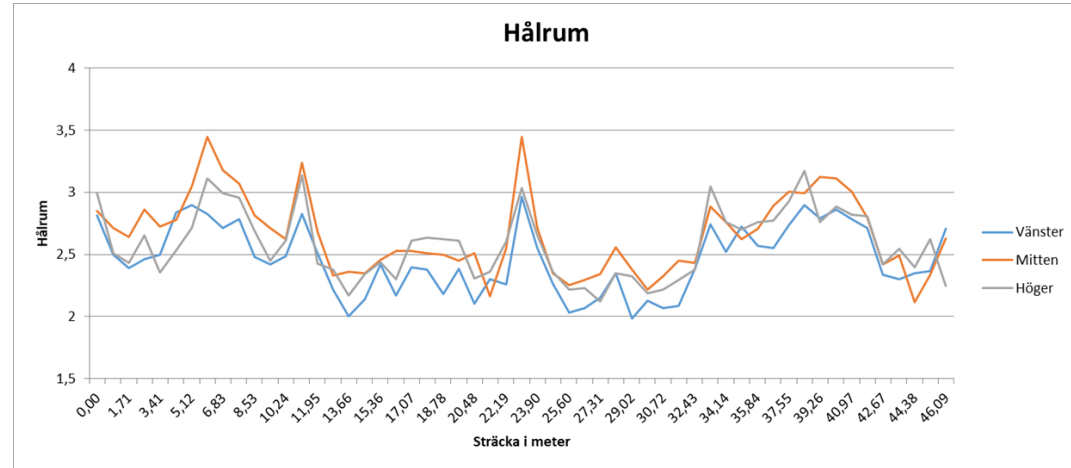
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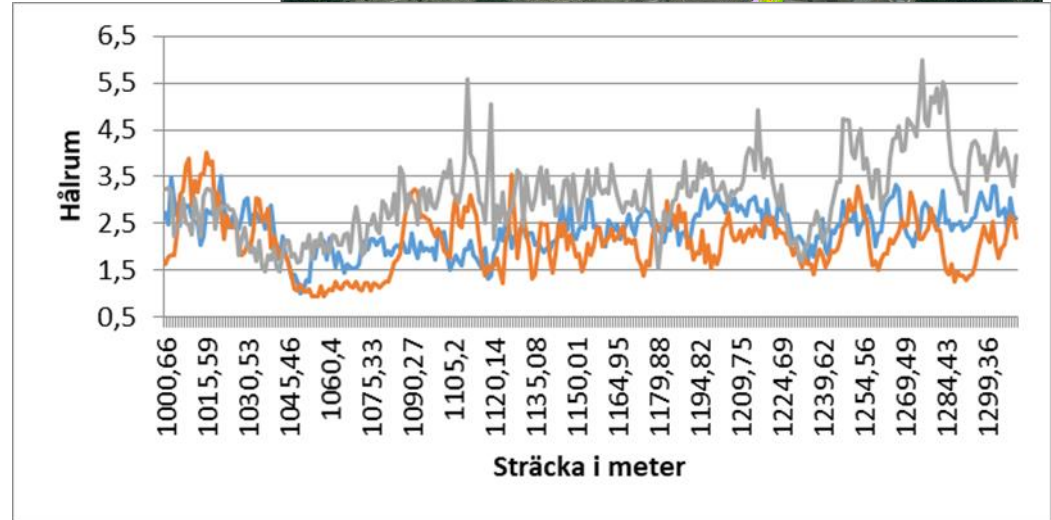
# Transverse measurements

- We have started doing transverse measurements
- Unique mix
- New correlation



# Visualising results

- Graphs
- ArcGIS

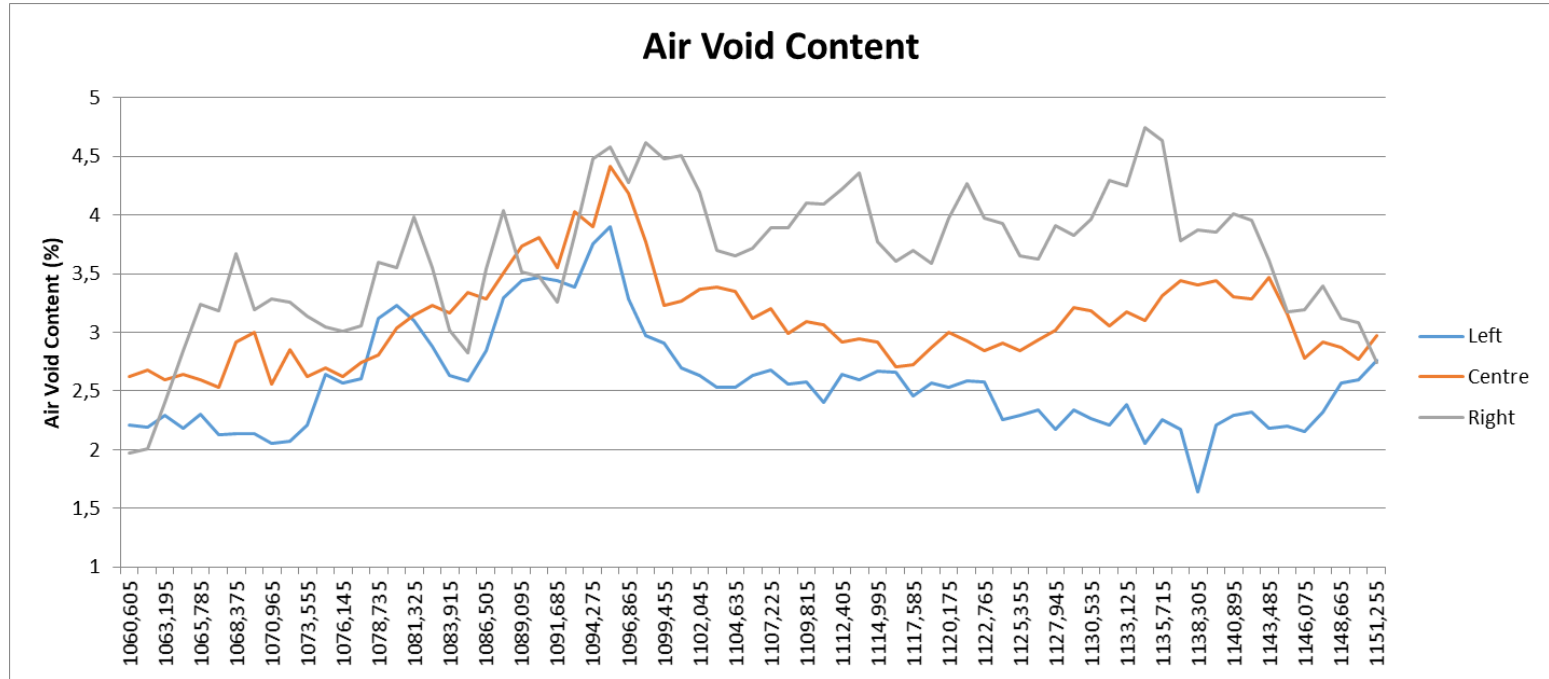


# Visualising results

- Graphs
- ArcGIS



# Working with excel



# Example report

- Front page
- Object information + notes
- Calibration information
- Graphs and statistics



Rapport av resultat från packningskontroll och homogenitet  
med teknik som bygger på georadar

Objekt:  
2019-03-27



# Example report

- Front page
- Object information + notes
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- Graphs and statistics

## Objekt information

**Objekt:** Generic ABT road  
**Mätläge:** 3 channels  
**Entreprenör:** Entreprenör A  
**Asfalt:** Asphalt plant A  
**ABT:** ABT  
**Struktur:**  
**Struktur:**  
**Struktur:** Summer  
**Struktur:** Gustav Tenby  
**Utrustning:** GSSI RDM - 2,5Ghz - 3 KHz

## Karta över mätobjekt

Start:	
Slut:	

## Noteringar

- The conditions during this measurement was good.

# Example report

- Front page
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## Kalibreringsdata

Provtagare	A Smith
Provtagningsdatum	Summer
Analys utförd av	B Smith
Metod	SS-EN

För att utläsa hållrum från mätdata kalibreras uppmätt permittivitet mot ett antal borrhov, minst sex, tagna från den lagda ytan, eller från annan yta med samma förutsättningar gällande massa och metod. Uppmätt permittivitet från georadarmätningar jämförs med hållrum från motsvarande borrhov. Sambandet mellan de två bestäms matematiskt genom regressionsanalys. Vid  $R^2$  värden som markant understiger 0,75 blir sambandet mellan permittivitet och hållrum osäkert. Permittivitet kan fortfarande användas indirekt för bedömning av kvaliteten i beläggningen genom bedömning av insamlade värdenas homogenitet.

I fall där korrelationen understiger 0,50 rekommenderar vi istället en bedömning av beläggningens kvalitet genom granskning av uppmätta permittivitetsskeden. Vid korrelation understigande 0,50 redovisas permittivitet istället för beräknad hållrumshalt.



# Example report

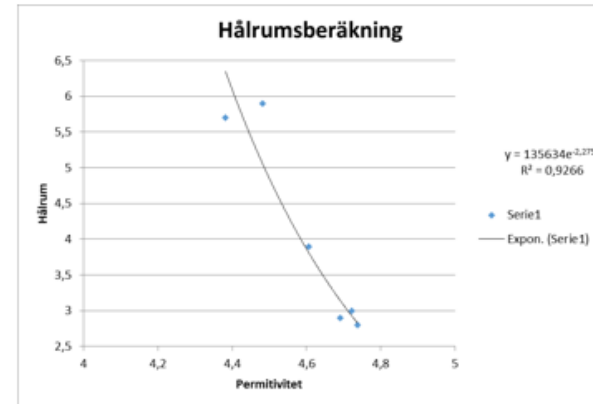
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## Borrkärnor

Märkning prov	Permittivitet (ε)	Hålrum (volym %)	N	E
1	4,69	2,9		
2	4,6	3,9		
3	4,72	3		
4	4,48	5,9		
5	4,38	5,7		
6	4,73	2,8		

Korrelationsfaktor:  $R^2 = 0,92$

## Korrelation



# Example report

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## Data

Start:	
Slut:	

Antenn	Medel	Std. V	Varians	$\Delta H$	$\Delta C$	$\Delta V$
Höger #64				-		
Center #67					-	
Vänster #65						-

Noteringar:

Permittivitet
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# Questions?

Thank you for listening!