

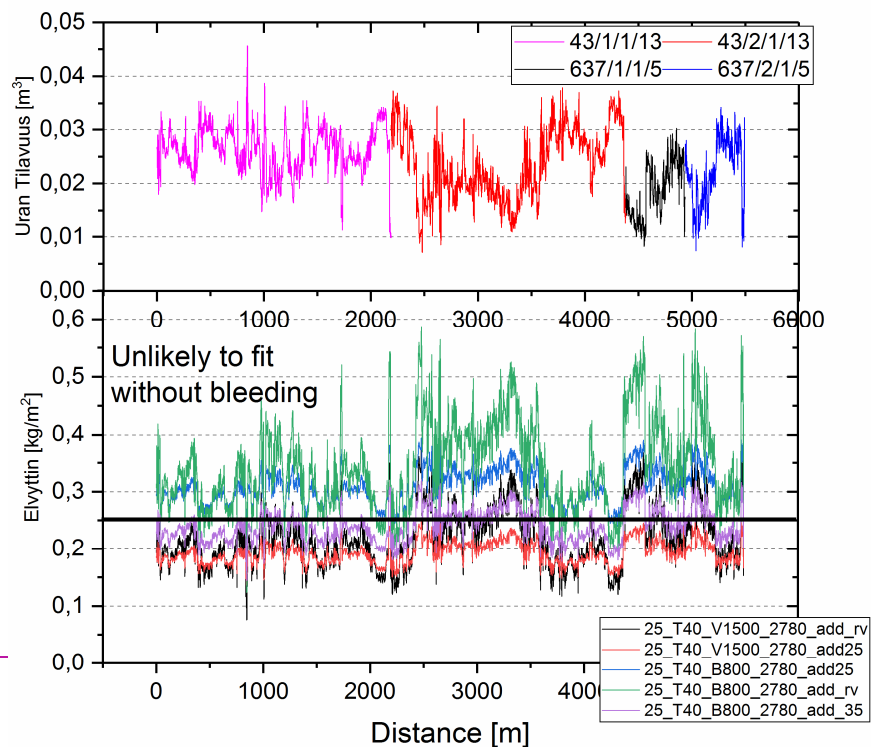
Based on those example calculations on the example of **2500 kg/m<sup>3</sup>** density the suggested choices would be either:

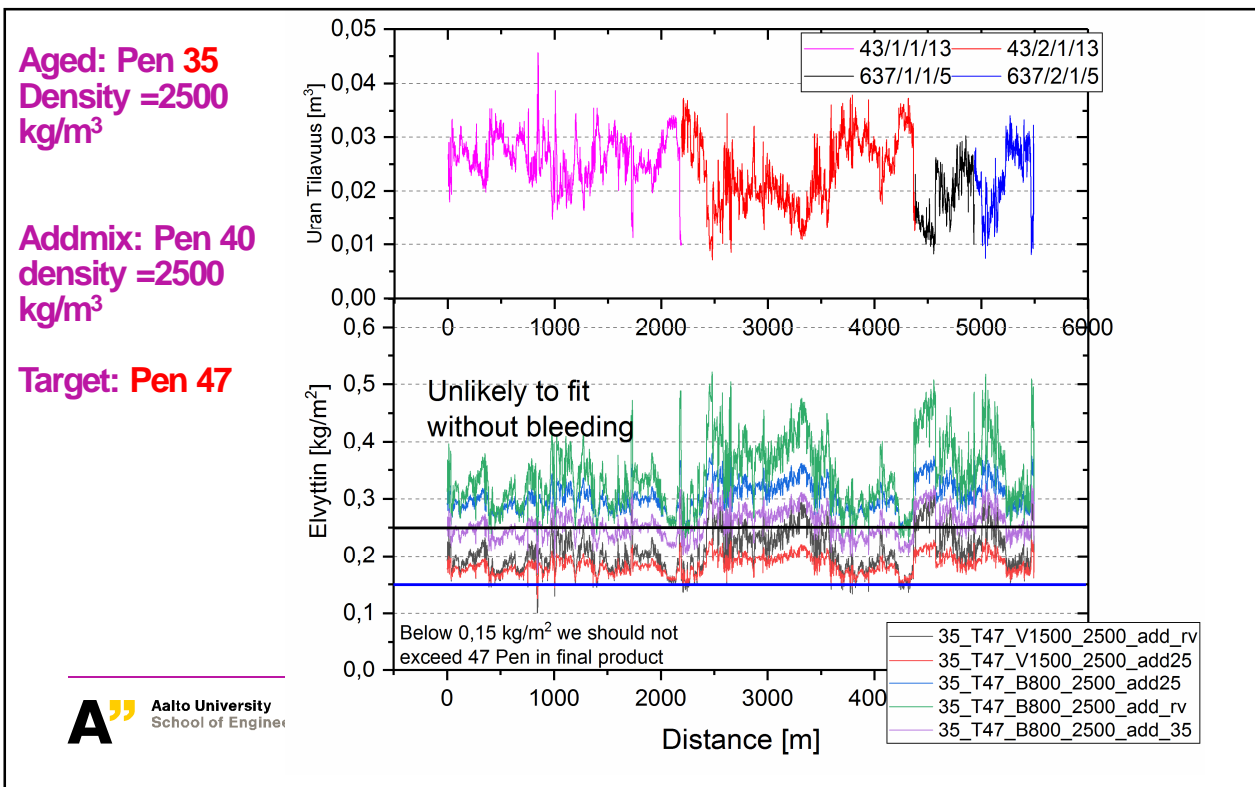
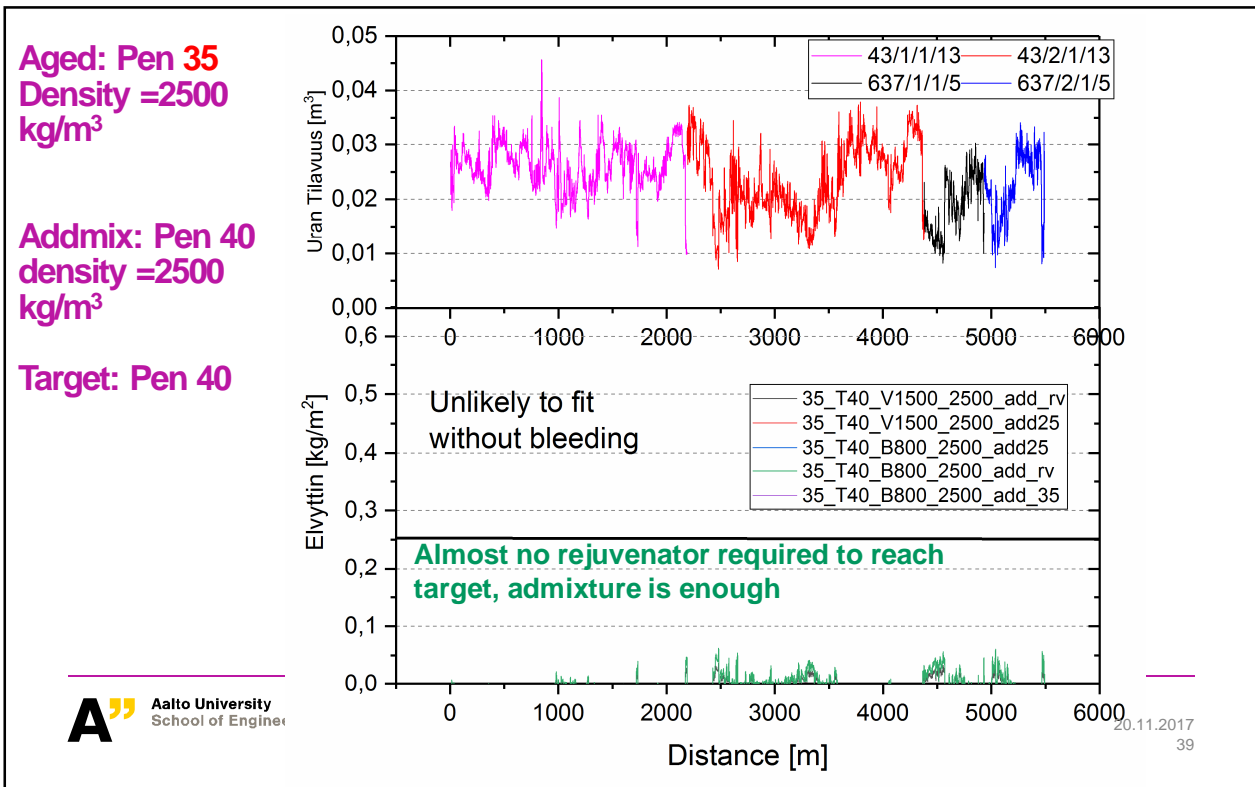
- Announce that the pavement at **25 dmm** with **25 kg/m<sup>2</sup>** and **250 g/m<sup>2</sup>** of **650/900** as a rejuvenator cannot restore the rheological properties to the target, **remove the material** and **overlay with fresh mixture, reuse RAP elsewhere** (esim. RC25)
- If profile allows choose **35 kg/m<sup>2</sup>** of admixture and allows for the rejuvenator **650/900** to be used (then the value between **150-250 g/m<sup>2</sup>** is required to restore the rheological properties to desired)
- Choose **25 kg/m<sup>2</sup>** of admixture and allow for the **V1500** to be used (between **100-200 g/m<sup>2</sup>**)

Aged: Pen 25  
Density =2780  
kg/m<sup>3</sup>

Addmix: Pen 40  
density =2780  
kg/m<sup>3</sup>

Target: Pen 40



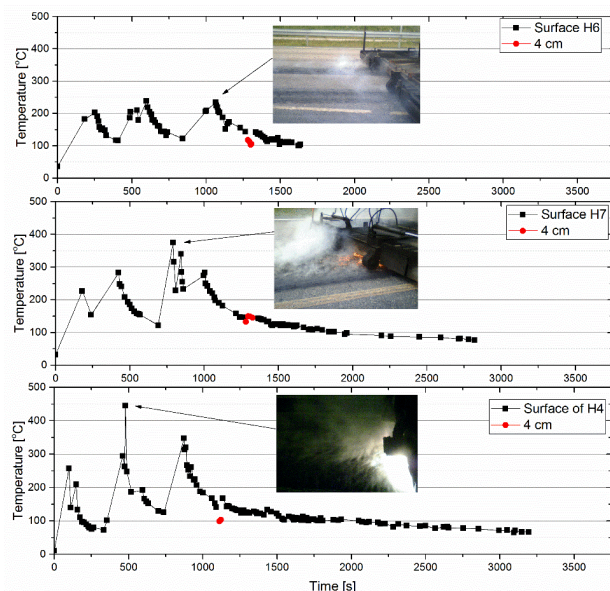




# First step to thermal control of the process (vision)

## The ignition problem identified

ASSESSMENT OF RISKS IN THE HOT IN-PLACE RECYCLING IN FINLAND DURING THE SUMMER OF 2016  
Makowska M., Pellinen T., Solowski W.,  
Baltic Road Conference 2017, 27-29  
August 2017, Tallin, Estonia

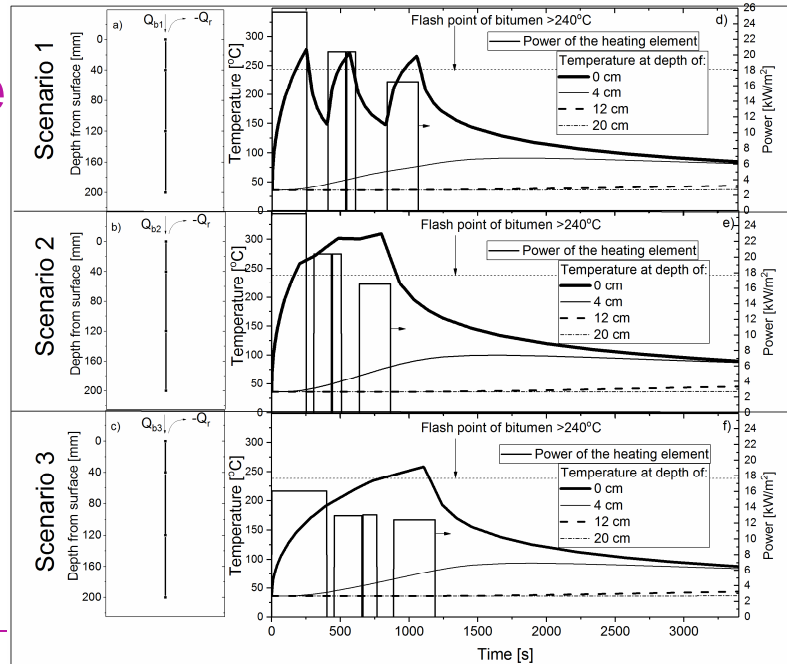


# Solutions are available

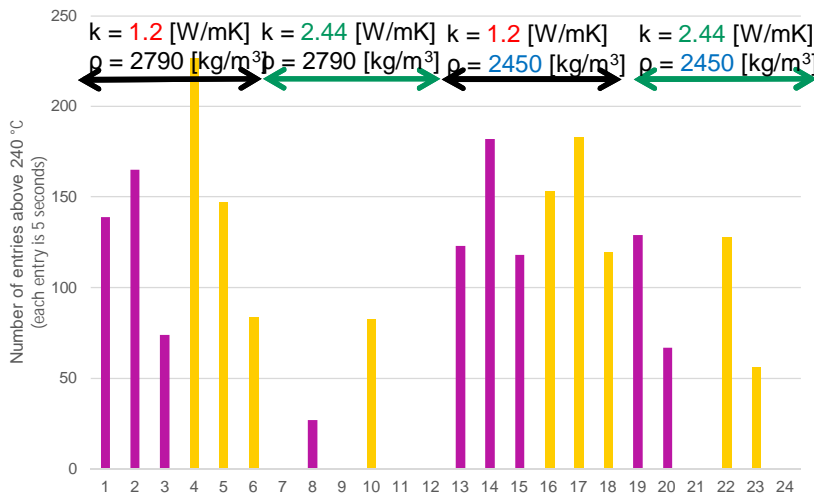
This solution is presented for one material

à Use of the same heat/power\*time/

What happens when the material changes?



20.11.2017  
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For low thermal conductivity, the temperature accumulates on the surface

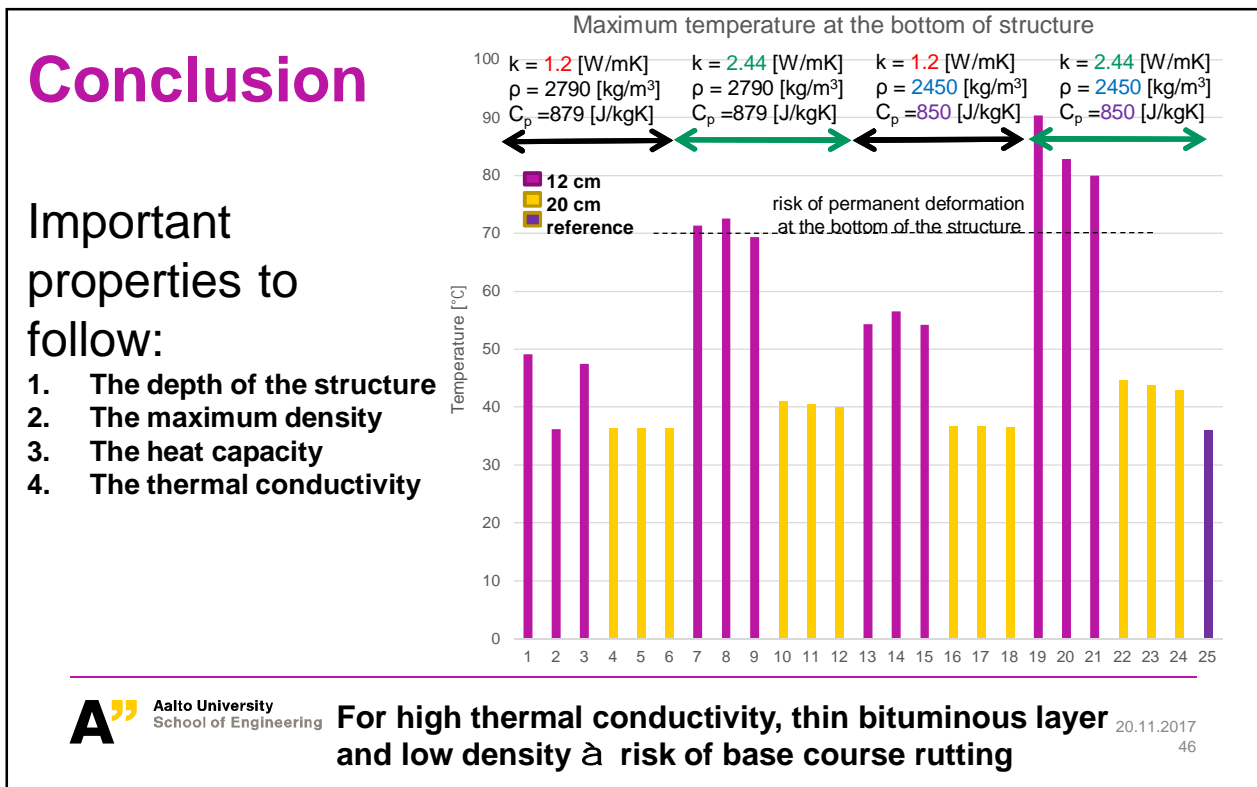
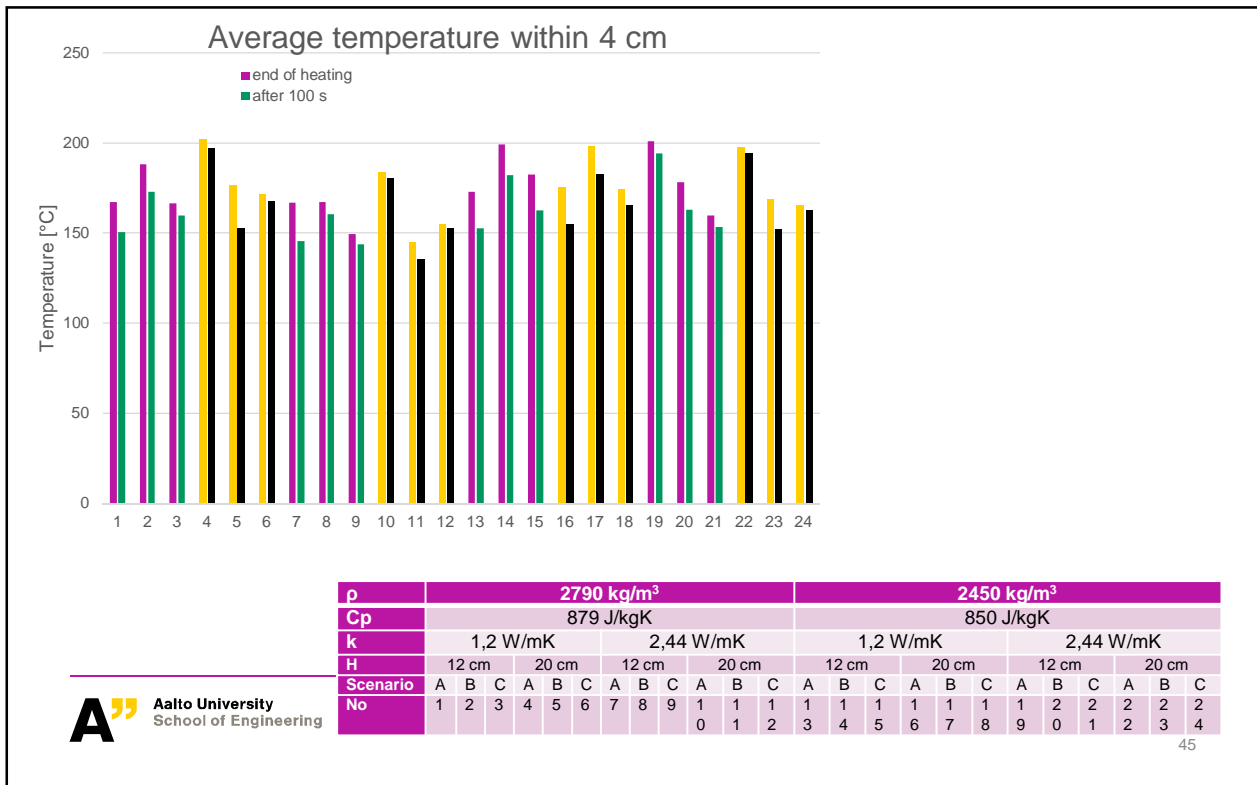
à Increased risk of ignition

$\rho$	2790 kg/m <sup>3</sup>						2450 kg/m <sup>3</sup>											
$C_p$	879 J/kgK						850 J/kgK											
$k$	1,2 W/mK			2,44 W/mK			1,2 W/mK			2,44 W/mK								
$H$	12 cm		20 cm		12 cm		20 cm		12 cm		20 cm							
Scenario No	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
							0	1	2	3	4	5	6	7	8	9	0	1



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# Discussion regarding sampling

## What should be?



SFS-EN 13108-8:2016  
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SUOMEN STANDARDISOIMISLIITTO SFS  
FINNISH STANDARDS ASSOCIATION SFS

### 5.5.3 Test frequency and number of samples (n)

The test frequency to determine the number of samples (n) for the testing according to 5.5.4 shall be taken from Table 1, with level Z being the minimum test frequency under all circumstances.

Where (n) equals the quantity of feedstock (5.5.1) divided by the test frequency.

The level should take into account the source of the reclaimed asphalt, its intended use (mix group and type) and the intended addition percentage and may be defined in documents relating to the application of asphalt products.

Table 1 Minimum frequency for testing the reclaimed asphalt

Level	Tonnes/test
X	500
Y	1 000
Z	2 000

The minimum number of samples (n) per feedstock shall be 5.

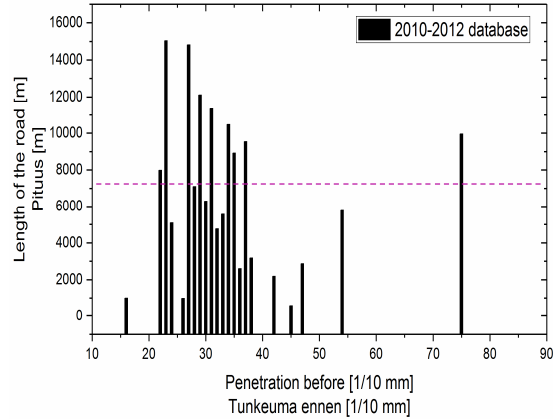
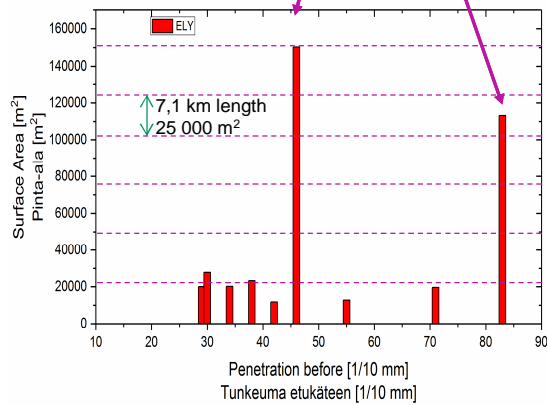
When the reclaimed asphalt is intended for use only at addition percentage of less than 20 % in base and binder courses and a percentage less than 10 % in surface courses, a single sample per feedstock may be specified.

The mean of 5 samples is to be reported for bitumen and aggregate properties.  
**1 core = ca. 500 g**

**800g \* 5 à aggregate**  
(50\*D = 800 g for SMA16 à 1 sample)  
**1666g \* 5 à bitumen Pen**  
(1666 g \* 6% = 99,96 g bitumen à 1 sample)  
**=>16 cores per feedstock**

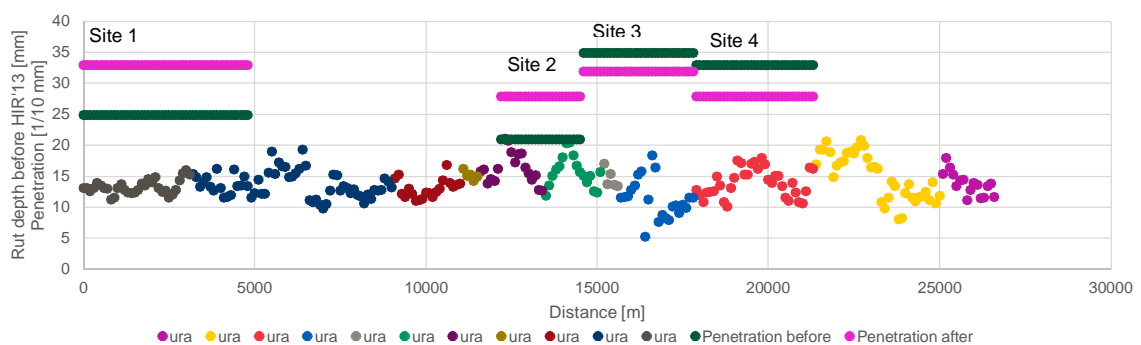
2000 000 kg /80 kg/m<sup>2</sup> /3,5 m width =>  
7,1 km length or **25 000 m<sup>2</sup>**  
à At least 1 sample per  
7,1 km or 25 000 m<sup>2</sup> at 80  
kg/m<sup>2</sup> aged pavement  
assumption

## Currently.... 1 bitumen per construction site



## How can we benefit from more frequent sampling?

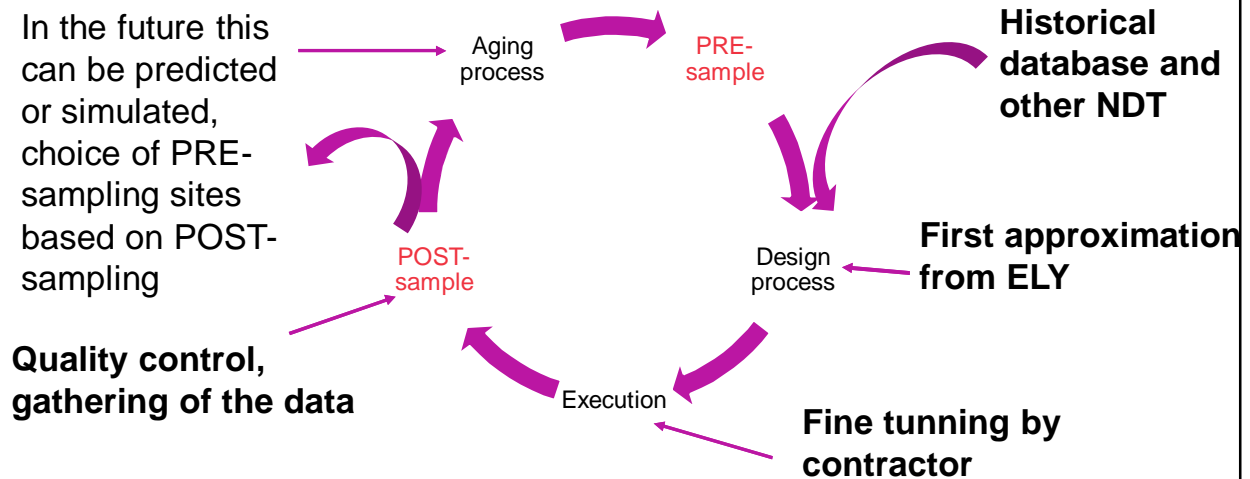
Example of rut depth and rheology combination (Highway no. 1, 26 km length)



Using the Global Aging System (GAS) we can predict that for Pen 27, 33 and 40 after the REMIX the time to reach the damage zone (Pen 21) it will take 15, 28 and 36 months. (Input value is ZSV at 70 deg C)

**Let's improve GAS for Finland (database+air voids)!**

## The planning-execution-quality control process



## Conclusions regarding sampling

1 bitumen sample per 7,1 km minimum

- Check if the DCM is present (is the result real?)

Maximum density is important for estimation of bitumen ratio between fresh and aged pavement

In the future – the estimation of required heat

- Air voids may play a role in the aging of the bitumen and should be also gathered in the database along the rheological properties.

Rest is suggested to remain unchanged.