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Kennisplatform Betonwegen  
Themabijeenkomst  
'Weerbaar beton'

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Onderzoeker - OCW

De slabtest onder de loep en invloed  
van hydrofobeermiddel – *Ervaringen in  
België en het GELAVIA-onderzoek*

Venlo - 13/11/2018



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GELAVIA

Introduction

Durability of concrete road largely dependent on freeze-thaw resistance with de-icing salts

Long term experience and limiting values in Belgium exist as a function of traffic load:

- ✓ concrete composition ( $C_{min}$ , w/c factor, air content)
- ✓ test method: resistance to scaling

New test method: update of limiting values

National pre-normative research project GELAVIA





## GELAVIA

### Traffic class and concrete composition in Belgium

	D <sub>max</sub> aggregates (mm)	Cement content (kg/m <sup>3</sup> )	Water/cement ratio (%)	Air content (%)
<b>Heavy trafficked roads (B1-B5/ Réseau I)</b>				
Top layer (1 or 2 layers)	> 20 mm 6,3 mm < D <sub>max</sub> ≤ 20 mm ≤ 6,3 mm	≥ 400 ≥ 400 ≥ 425	≤ 0,45 ≤ 0,45 ≤ 0,42	- ≥ 3 <sup>(1)</sup> ≥ 5 <sup>(1)</sup>
	≥ 20 mm	≥ 375	≤ 0,45	-
<b>Low trafficked roads and bicycle lanes (B6- B10, BF/Réseau II-III)</b>				
Top layer (1 or 2 layers)	> 20 mm 6,3 mm < D <sub>max</sub> ≤ 20 mm ≤ 6,3 mm	≥ 350 ≥ 375 ≥ 400	≤ 0,50 ≤ 0,50 ≤ 0,45	- ≥ 3 <sup>(1)</sup> ≥ 5 <sup>(1)</sup>
	≥ 20 mm	≥ 350	≤ 0,50	-

<sup>(1)</sup>In the last version of Flemish SB 250, the air content is to be declared during the initial type testing



## GELAVIA

### Determining resistance to scaling

- Freeze-thaw cycles on samples whose surface is covered with a layer of de-icing salt solution
- Evaluation of freeze-thaw resistance by weighing the scaled material after a specified number of cycles





## GELAVIA

### Test method

- In the past: all regional tender specifications based on “ISO/DIS 4846.2”
- New testing method CEN/TS 12390-9: “Slab-test”, converted into “RNR 06” applied in SB 250 specification
- Limiting values :

Specification	Test method	Number of cycles	Unit	Traffic class	
				B1-B5/RI	B6-B10, BF/RII, RIII
Qualiroutes	ISO/DIS 4846.2 (“CME 53”)	30	g/dm <sup>2</sup>	≤ 5	≤ 10
CCT2015	ISO/DIS 4846.2	30	g/dm <sup>2</sup>	≤ 5	≤ 10
SB 250	CEN/TS 12390-9	28	kg/m <sup>2</sup>	≤ 1,500	≤ 3,000



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### Test method – Belgian complements to European standard

	Slab-test RNR06	CEN/TS 12390-9 (Slab Test)
Test surface	4 cores extracted from cubes- cast sides tested	Sawn surface of 4 cubes (15x15x15) cm <sup>3</sup>
Number of cycles	28 (24h each)	56 (24h each)
Preparation test specimen	28d under water (20 ± 2)°C 14d in climate chamber at (20 ± 2)°C and (60 ± 5)% RH	7d under water (20 ± 2)°C 21d in climate chamber at (20 ± 2)°C and (65 ± 5)% RH
Collecting scaled material	Rinsing bottle	Brush

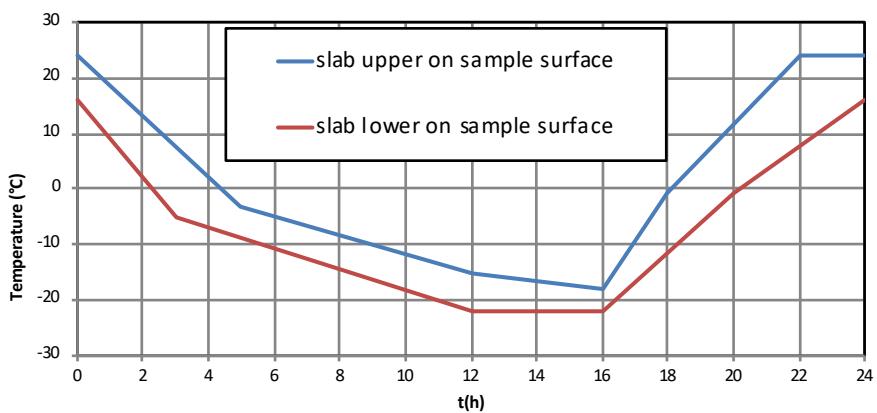
See Annex E of RNR06 @ <https://www.copro.eu/nl/document/rnr-06-10-reglementaire-nota-voor-technische-fiches-verantwoordingsnotas-en-voorstudies-0>



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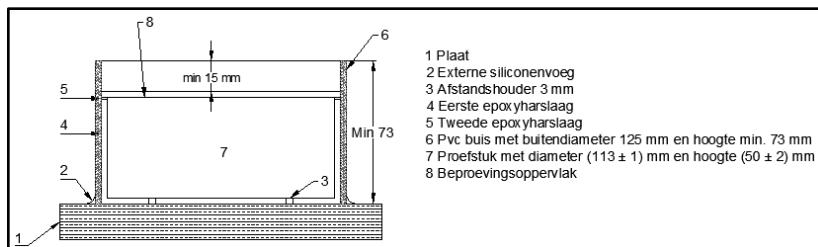
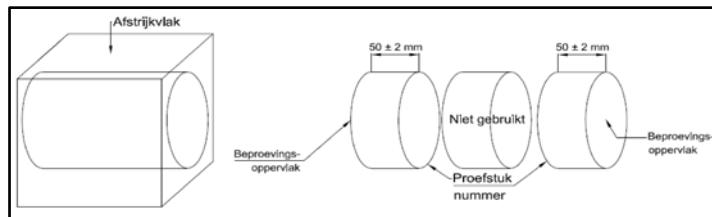
### Test method - temperature profile



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### Test method - details





## GELAVIA

### Test method

#### Leeftijd (dagen)



0 Betonnering

1 ontkisten na 24( $\pm 2$ )h + (uitwassen) + onder water 20 ( $\pm 2$ )°C

21 Boren + verzagen proefstukken

28 Bewaring bij T: (20  $\pm 2$ ) °C en RV: (60  $\pm 5$ ) %

41 Opmeten proefstukken + voorbereiden pvc-buis

42, 43, 44 of 45 Epoxyharslaag

46 Start van de verzadiging

49 Isolatie proefstukken + 3 mm zoutoplossing + start proef



## GELAVIA

### Test method – collection of scaled material

Nr.dag	
56	Recolteren 7 Cycli
63	Recolteren 14 Cycli
70	Recolteren 21 Cycli
77	Recolteren 28 Cycli
91	Recolteren 42 Cycli
105	Recolteren 56 Cycli
112	Recolteren 63 Cycli



Orange = in the research only!



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## GELAVIA

### Research project

- Validation of limiting values for commonly used mix compositions for road concrete in Belgium.
- Comparison finished surface, sawn surface and cast surface
- Effect and durability of hydrofobic impregnation products
- Validation on road construction sites



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## GELAVIA project

### Selection of mix compositions

- Compositions of heavy trafficked roads (traffic classes RI and B1-B5) and medium trafficked roads (traffic classes RII and B6-B10)
- Surface finishing: brushed or exposed aggregates
- Materials used in Belgium for road concrete:
  - ✓ CEM III/A 42.5 N LA: 375 and 400 kg/m<sup>3</sup>
  - ✓ Rounded sand (0/2 and 0/4),
  - ✓ Belgian porphyry aggregates (4/6.3, 6.3/10, 10/14, 14/20)
  - ✓ Admixtures: plasticizer, air entraining agent



## GELAVIA project

### Selection of mix compositions

Code	Cement (kg/m <sup>3</sup> )	W/C ratio	air content (%)	Slump class	Surface finishing	
RI-400-S1-air-L	400	0.45	3-6	S1-S2	Exposed aggregates	
RII-375-S1-air-L	375	0.50	3-6	S1-S2	Exposed aggregates	
RII-375-S1-air-B	375	0.50	3-6	S1-S2	Brushed	
RI-400-S3-air-L	400	0.45	3-6	S2-S3	Exposed aggregates	
RII-375-S3-air-L	375	0.50	3-6	S2-S3	Exposed aggregates	
RII-375-S3-air-B	375	0.50	3-6	S2-S3	Brushed	
<i>RI-400-S3-L*</i>	400	0.45	-	S2-S3	Exposed aggregates	
<i>RI-400-S3W-L*</i>	400	0.51 (+water)	-	S2-S3	Exposed aggregates	
<i>RII-375-S3-L*</i>	375	0.50	-	S2-S3	Exposed aggregates	
<i>RII-375-S3W-L*</i>	375	0.56(+water)	-	S2-S3	Exposed aggregates	
<i>RII-375-S3-B*</i>	375	0.50	-	S2-S3	Brushed	
<i>RII-375-S3W-B*</i>	375	0.56(+water)	-	S2-S3	Brushed	

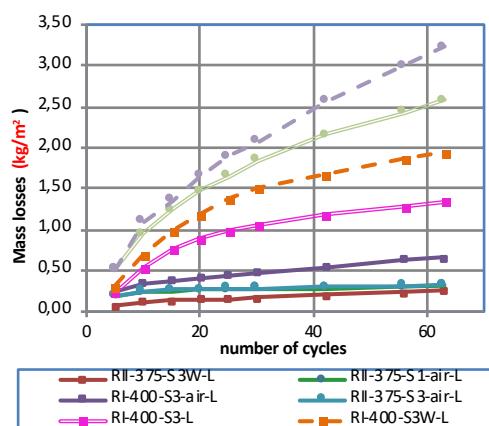
\*These compositions do not meet the tender specification requirements



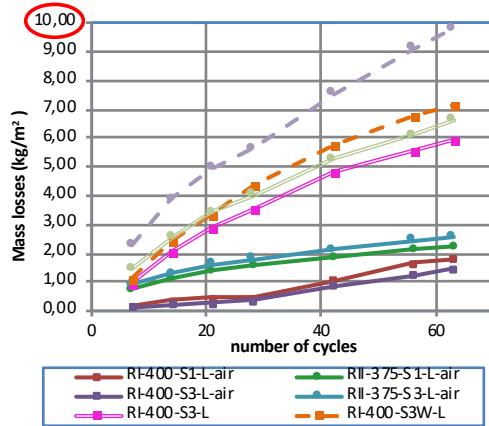
## GELAVIA project

### Results

ISO DIS Exposed aggregates



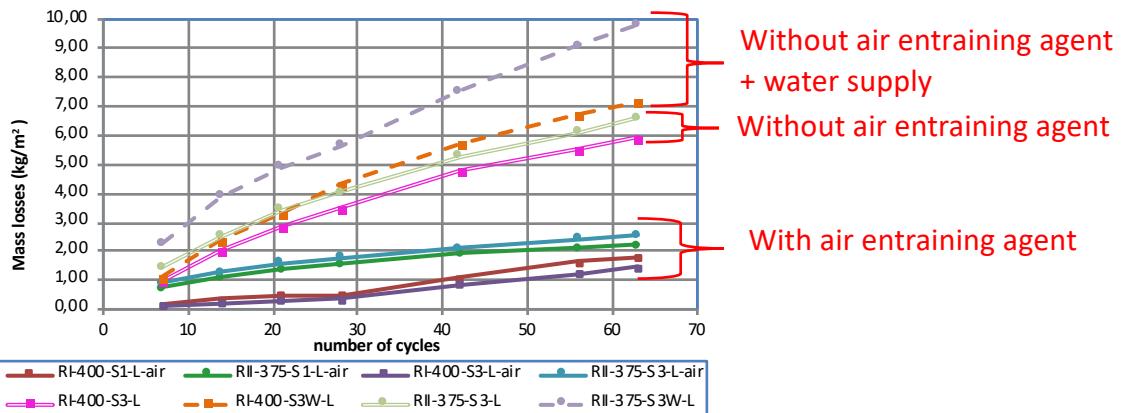
SLAB exposed aggregates





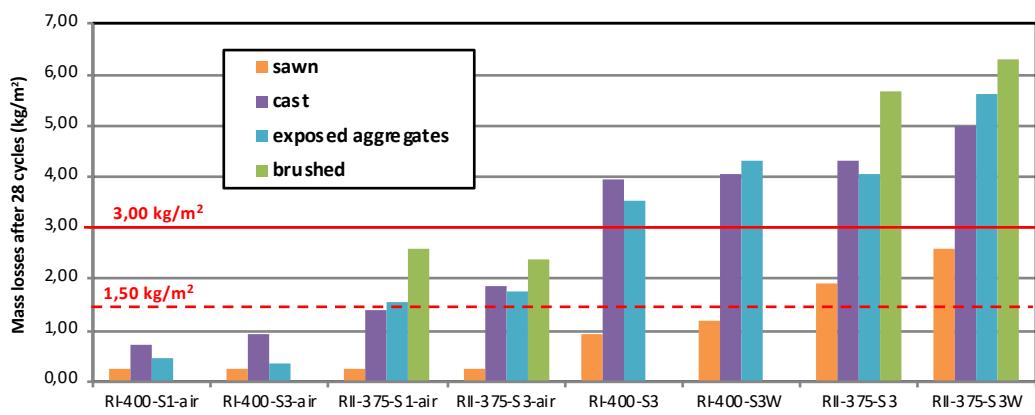
## GELAVIA project Results

SLAB exposed aggregates



## GELAVIA project Effect of surface

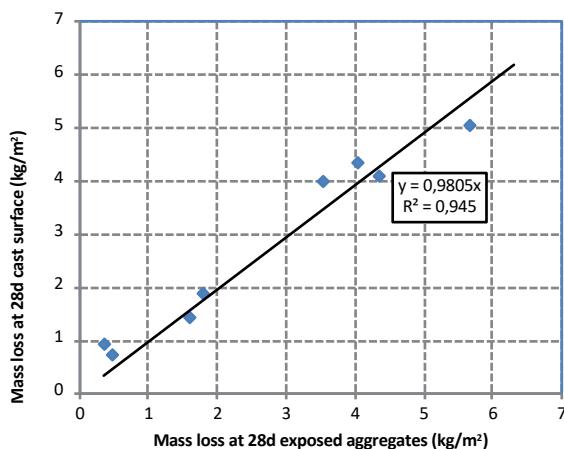
Slab method: influence of tested surface





## GELAVIA project

### SLAB: exposed aggregates vs. cast surface

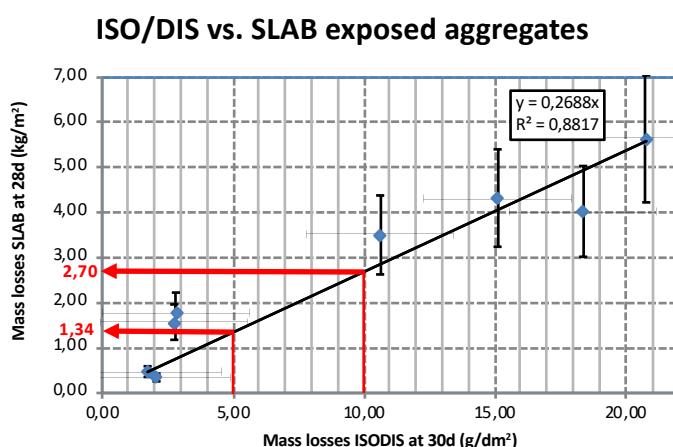


- Correspondance between certification study (RNR 06) and control on site (exposed surface)...



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### SLAB vs. ISO/DIS, exposed aggregates



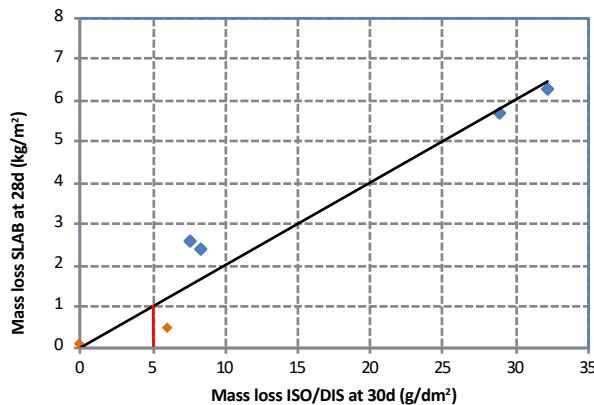
- Laboratory ≠ construction site! Tests still running
- Brushed surfaces?



## GELAVIA project

### Validation on site + effect of brushing

#### ISO/DIS-SLAB brushed surface



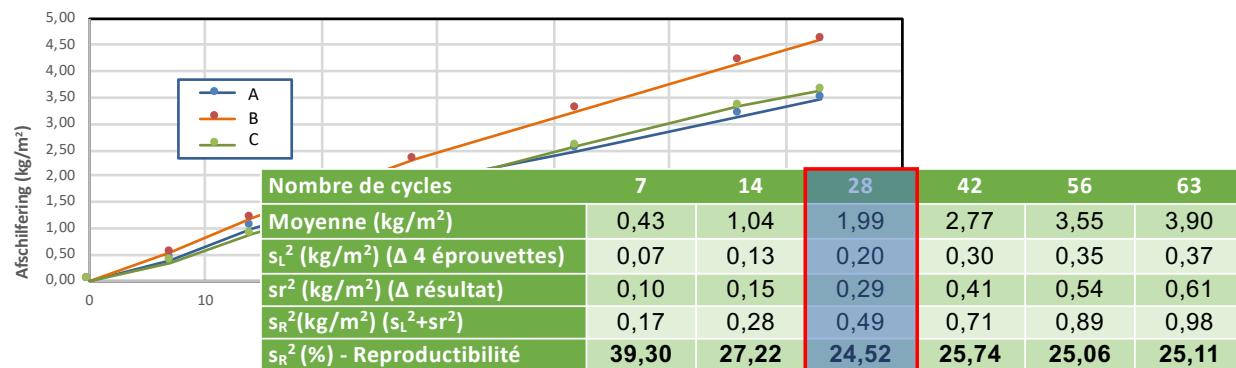
- Still running!



## GELAVIA project

### Interlaboratory testing: reproducibility Slab test?

- S4 beton met 360 kg/m<sup>3</sup> cement, W/C = 0,45, gezaagd oppervlak - voor labo's A en C: geteste oppervlakken uit zelfde zaagsnede





## GELAVIA project

### Hydrofobic impregnation

- In Belgium, hydrophobic impregnation product is required in some specific cases:
  - ✓ manual placement
  - ✓ colored concrete
  - ✓ imprinted concrete
- Performance characteristics defined in NBN EN 1504-2:
  - ✓ Penetration depth
  - ✓ Water absorption and resistance to alkali (NBN EN 13580)
  - ✓ Drying rate coefficient (NBN EN 13579)
  - ✓ Resistance against freeze-thaw salt stress



NBN EN 13581 ≠ CEN/TS 12390-9



## GELAVIA project

### Hydrofobic impregnation – current practice

- Current prescriptions based on EN 1504-2 in SB 250, version 3.1a:

#### 15.2 Impregneermiddel

Een impregneermiddel wordt aangebracht op het oppervlak van verhard beton om het oppervlak hydrofoob te maken en zo de indringing van water en dooizouten af te remmen. Er wordt geen film op het oppervlak gevormd en het uitzicht van het beton wordt nauwelijks of niet gewijzigd.

Het impregneermiddel voldoet aan NBN EN 1504-2 voor hydrofobe impregneermiddelen en TV BB-562. De kenmerken van het impregneermiddel voldoen aan tabel 3-15-1.

Kenmerk	Eis	Proefmethode
drogingssnelheid van de drager	≥ 30 %	NBN EN 13579
indringsdiepte	getest op C(0,70) getest op C(0,45)	≥ 10 mm ≥ 3 mm
		behandeling volgens NBN EN 13579, de proef mag uitgevoerd worden op proefstukken, aangemaakt voor de bepaling van de drogingssnelheid
bestandheid tegen alkaliën, absorptiegraad na onderdompeling in een alkali-oplossing	< 10 %	NBN EN 13580
weerstand tegen afschilfering, gecumuleerd massaverlies na 30 cycli	< 10 g/dm <sup>2</sup>	14-4.8 op referentiemonster C(0,45)

Tabel 3-15-1: kenmerken impregneermiddel

- Reference concrete ≠ road concrete !
- Correlation between properties and performance ?

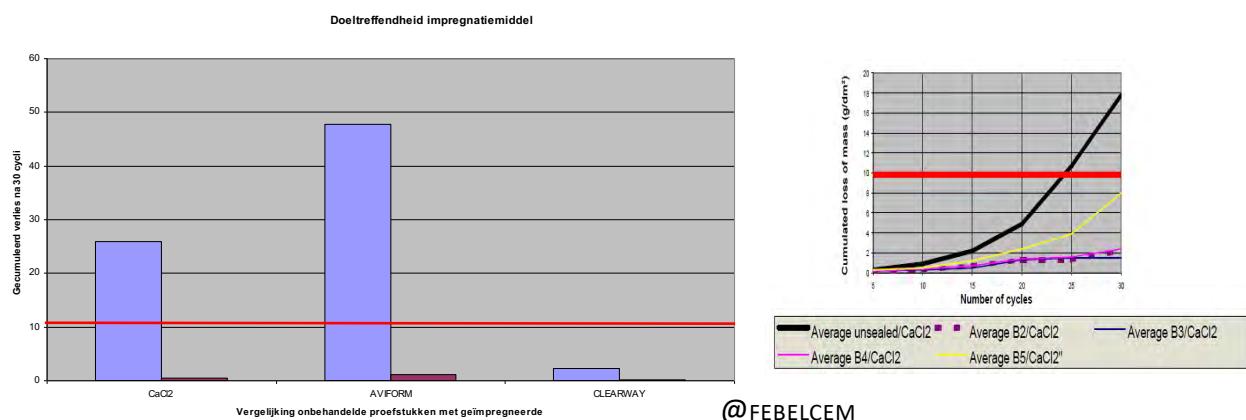


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### Hydrofobic impregnation – current practice

- Past results on road concrete with “old” ISO/DIS-method:



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## GELAVIA project

### Hydrofobic impregnation – goal of research

- Influence of hydrophobic impregnation products on resistance against scaling of road concrete?
- Influence of ageing of the impregnation products :



PEI (EN ISO 10545-7)



Wearing (EN 12274-5)



Q-SUN

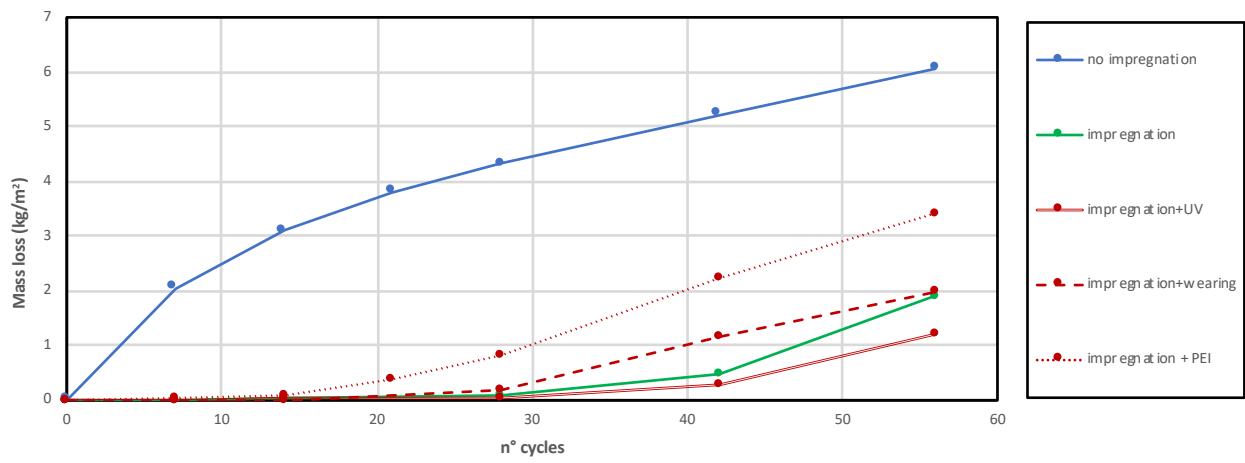
- Influence of curing compound?



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### Hydrofobic impregnation – first results

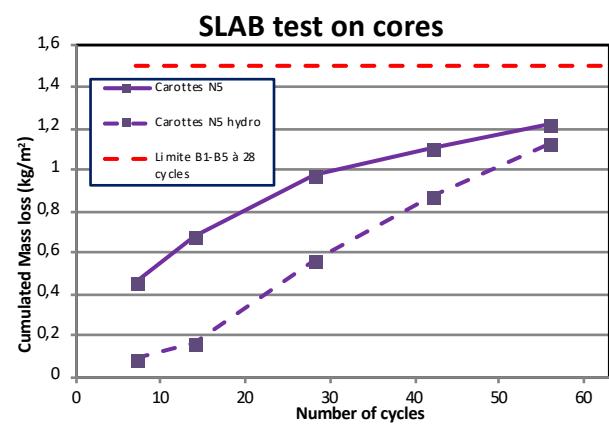


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### Hydrofobic impregnation – validation on site

#### N5 in Couvin



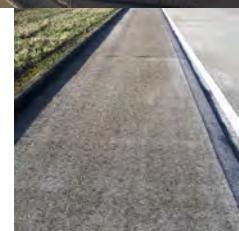
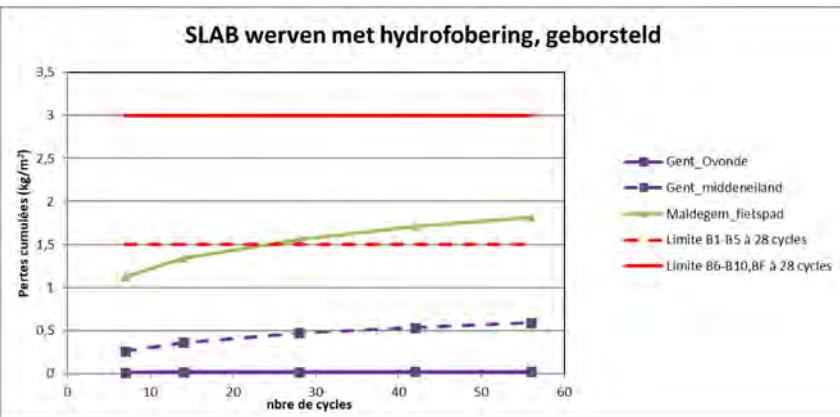


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## GELAVIA project

### Hydrofobic impregnation – validation on site

- TO BE CONTINUED !



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## GELAVIA project

### Conclusions

Based on laboratory testing:

- Slab test more aggressive than ISO-DIS test
- Limiting values close to new specifications , but need of results on brushed surfaces + more validation on site
- Important effect of surface finishing and of tested surface!



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## GELAVIA project

Still running...

- Effect of hydrofobic impregnation on resistance against scaling - Effect of ageing (UV and wearing)
- Evaluation on cores taken on working site to be compared with laboratory study



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Bedankt voor uw aandacht!

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