

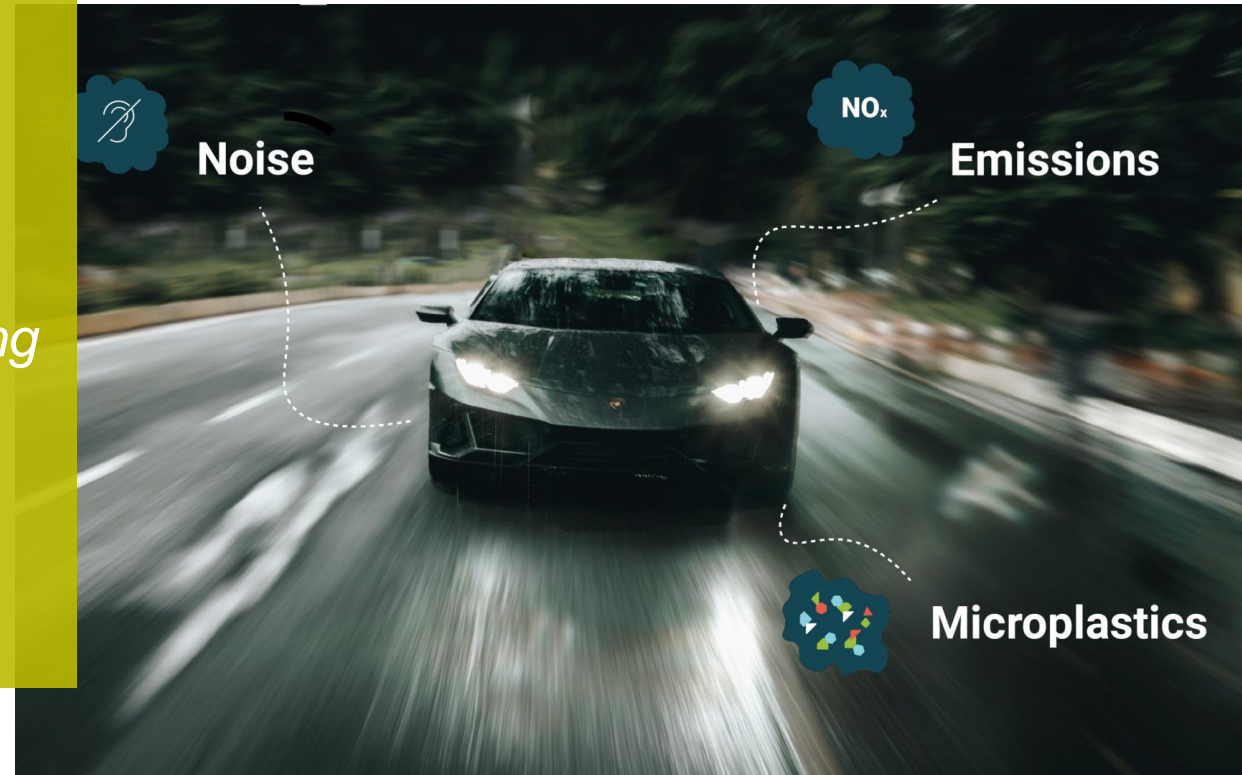


# Lessons learned from low noise pavements in urban areas

including results of the H2020 project **NEMO**

*Solutions for Low Noise Road Surfaces meeting  
6 Februari 2024*

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## Low noise pavements on Dutch motorways

- high speeds, little braking / turning → low tangential forces
- wide roads → water drainage is important
- increasing traffic and housing → traffic noise must be managed
- solution: porous asphalt concrete

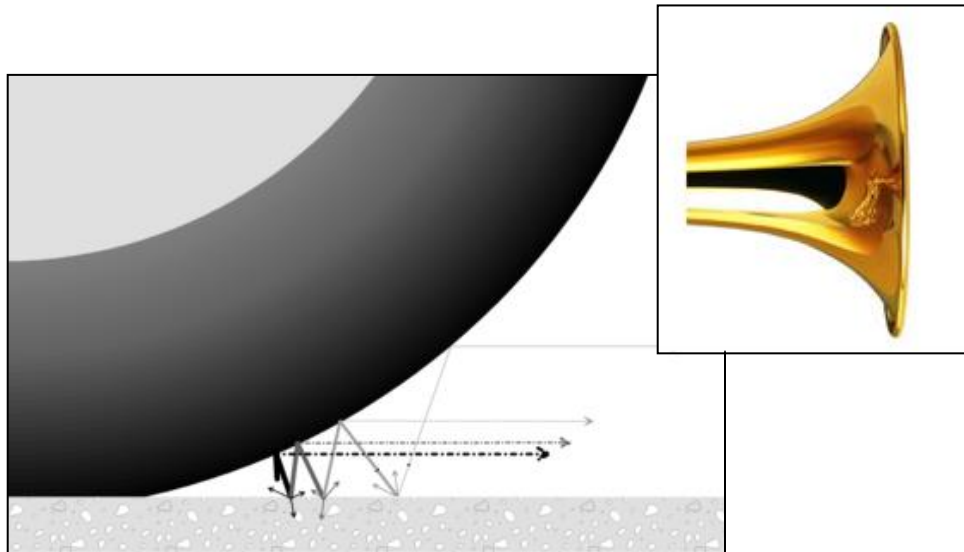




## Effects on tyre/road noise

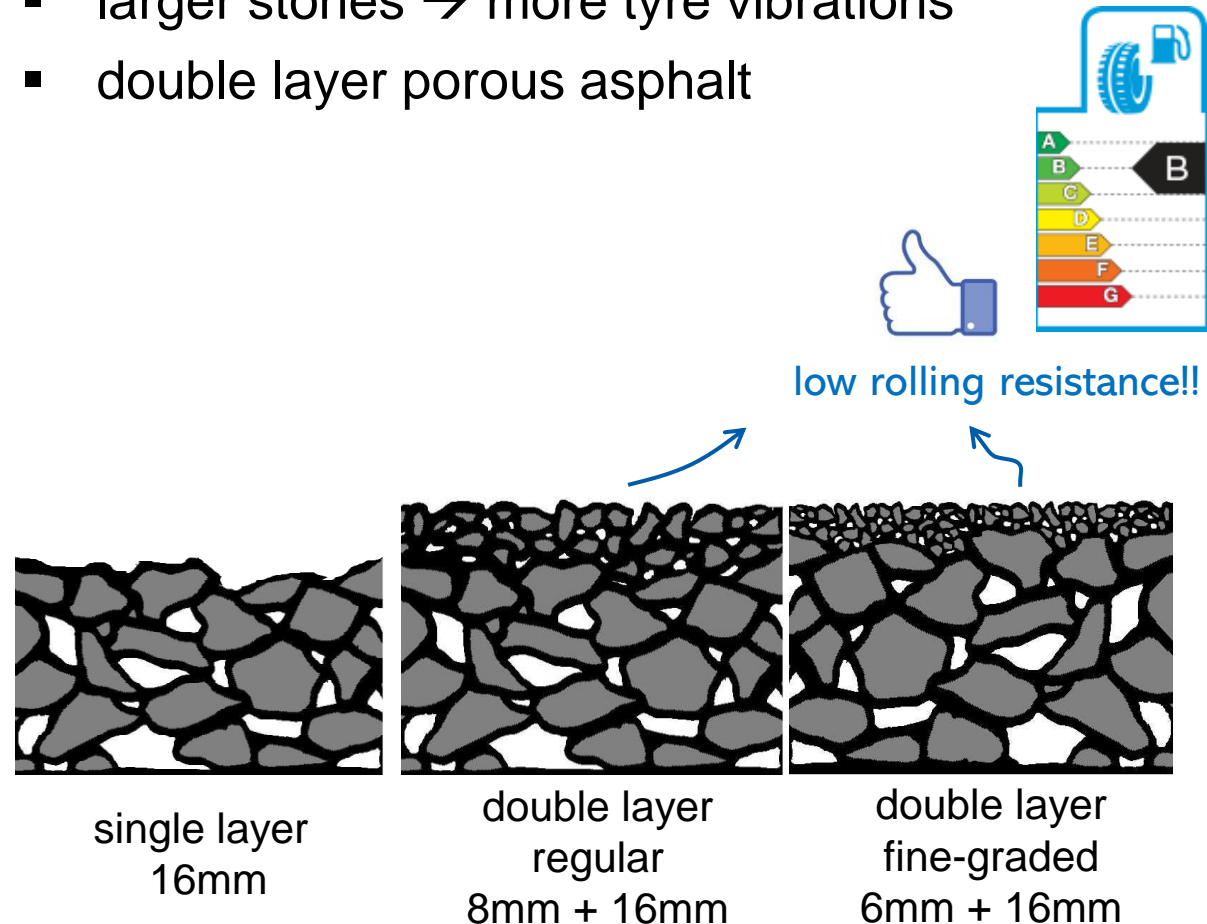
### sound absorption

- eliminates reflected sound waves
- reduces 'horn effect' amplification



### surface texture

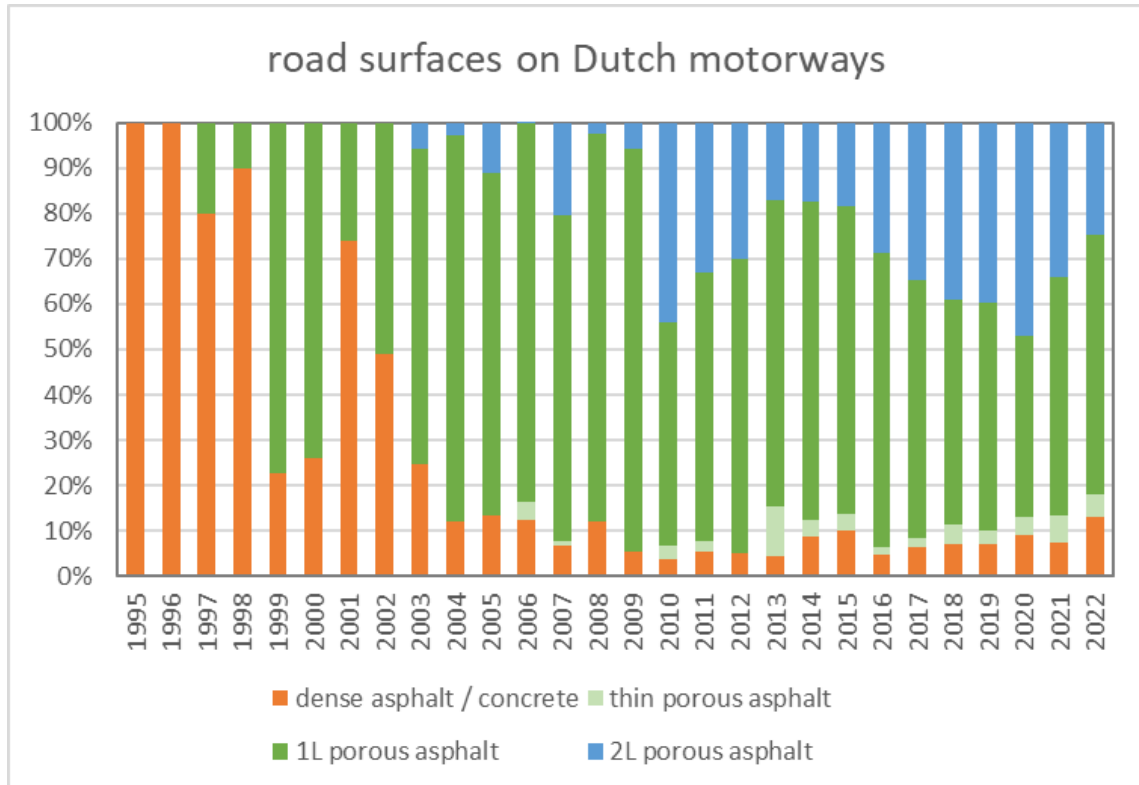
- larger stones → more tyre vibrations
- double layer porous asphalt





# Porous asphalt on Dutch motorways (Jan-2023)

- 6.636 km total road lane length
- 92% porous asphalt
  - of which 1/3rd double layer





## Lifetime and costs

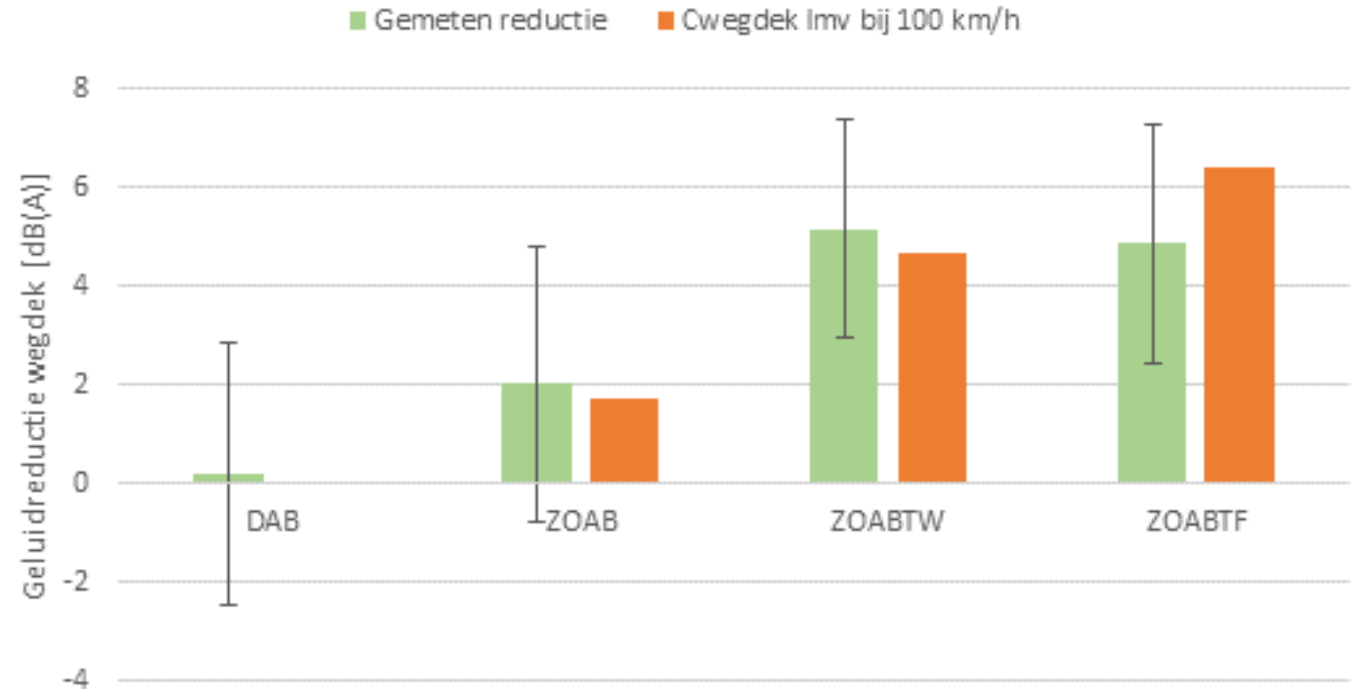
road surface	lifetime outer - inner lane	life-cycle costs	noise reduction mixed traffic
dense asphalt concrete	12 – 18 yrs	reference	0.0 dB(A)
single layer PAC	11 – 17 yrs	≈ reference	2.7 dB(A)
double layer PAC	9 – 13 yrs	+ 60%	4.9 dB(A)
double layer fine PAC	8 – 12 yrs	+ 84%	6.1 dB(A)

- lifetime: shorter, but manageable
- LCC costs: effect of shorter lifetime included
- noise reduction: averaged over lifetime



## Lifetime average noise correction factors

- noise reduction decreases with time & traffic
- correction factors for noise modelling (e.g. CNOSSOS-EU) are *lifetime average* values
- RIVM “CPX-like” measurements on 44 motorway locations, with pavements of all ages
- conclusion: good average match between model corrections & measurement results



*source: RIVM noise monitor 2022, supplementary report (2024)*





## Urban and regional situations (since the 00's)

- low noise road surfaces in urban and regional roads stimulated by the Dutch Government since 2001



■ thin surface layers

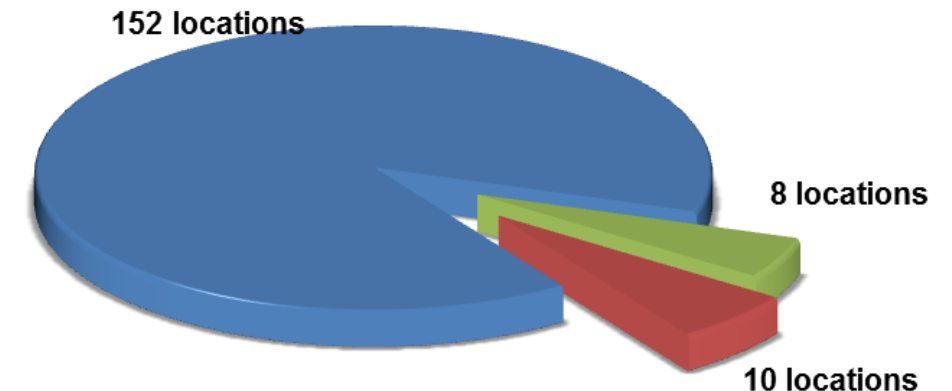


■ low noise paving blocks



■ two-layered porous asphalt

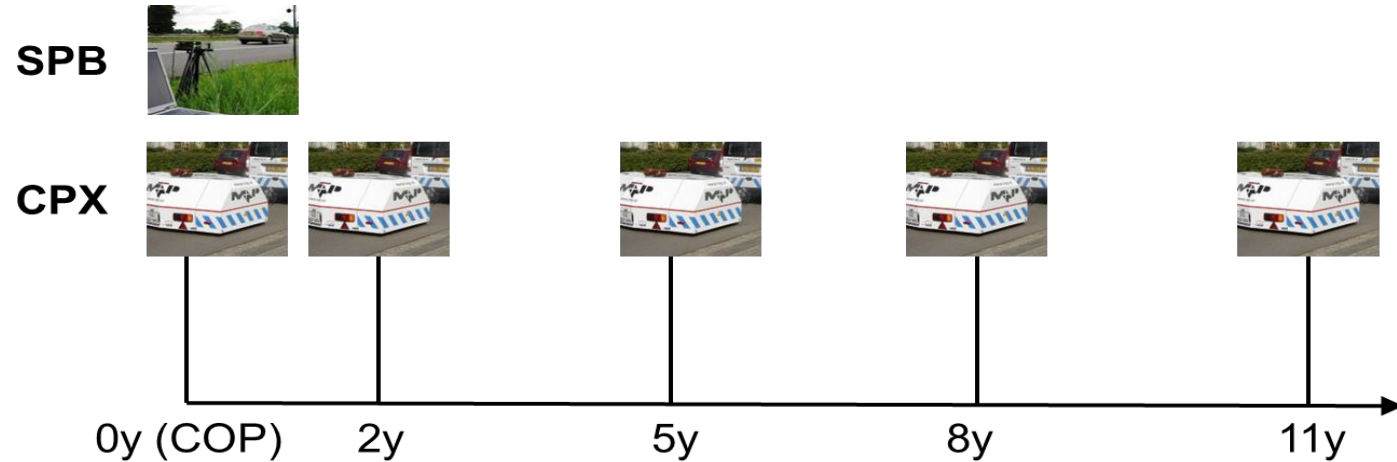
- mostly thin surface layers (TSL) have been laid
- TSL: better resistance against the mechanical wear in urban circumstances
- TSL: less porosity (<15%), optimized texture





# Monitoring acoustic behaviour of thin surface layers

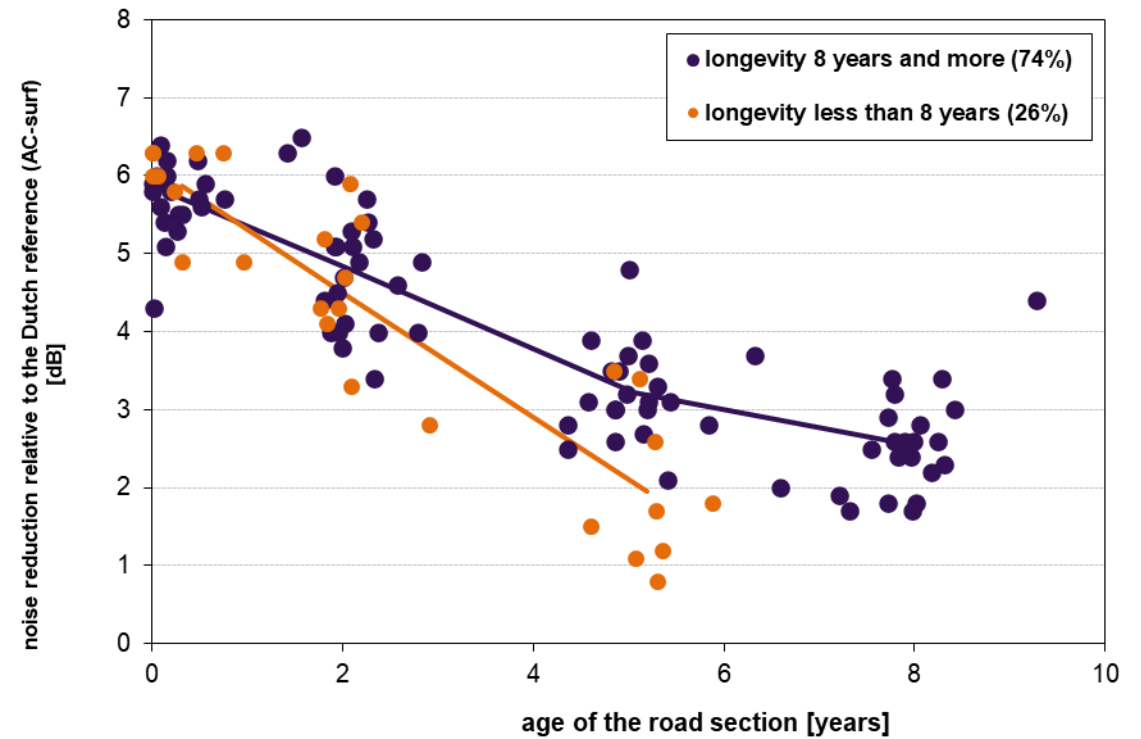
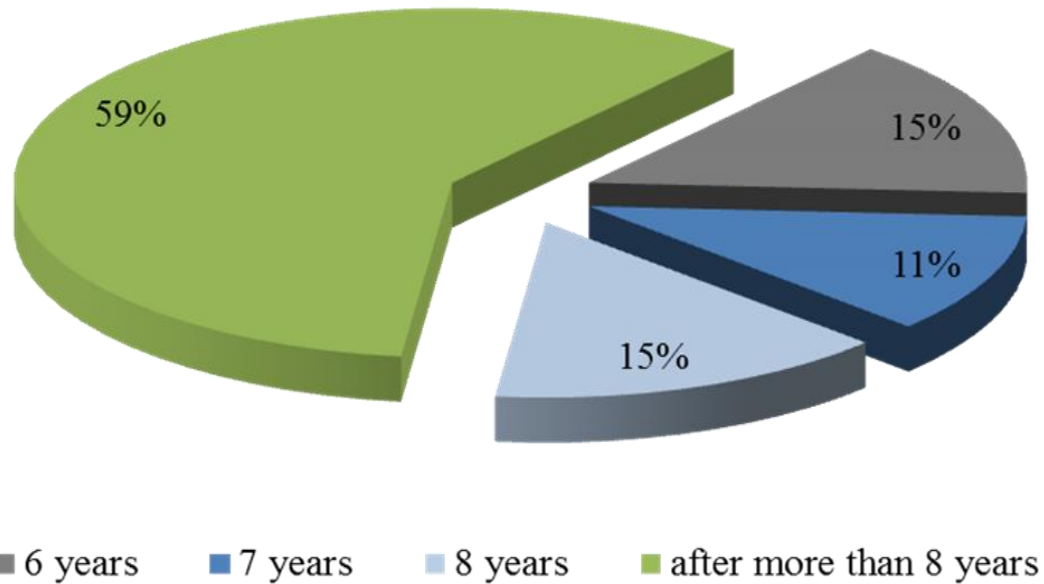
- selection of 31 locations in the Netherlands with the following conditions:
  - the measurement 8 years after laying has been performed
  - all results (initial and after 2, 5 and 8 years) are available
  - products from as many manufacturers as possible







## Experiences with the thin surface layers



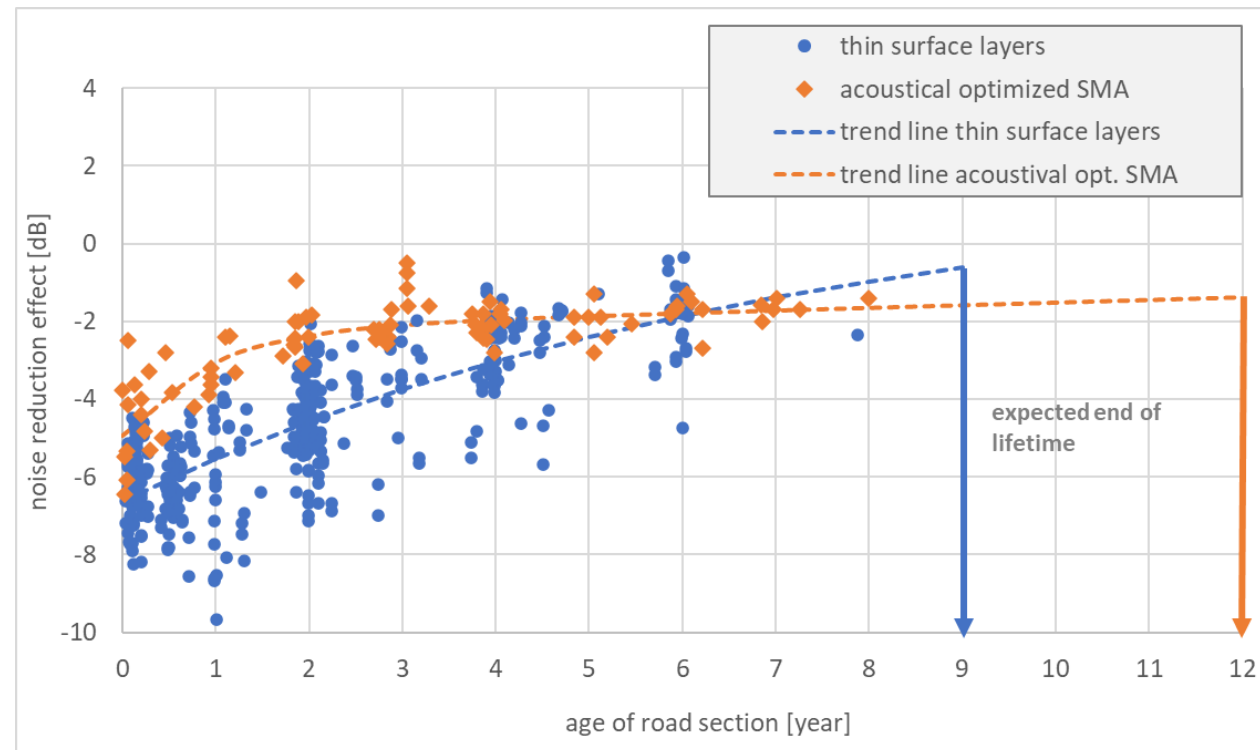
- estimated lifetime of TSL is 9 years
- 3 – 4 dB noise reduction averaged over the lifetime
- loss of stones and ravelling are the main reasons for replacing the surfaces



## Acoustically optimized SMA

- more durable (replacement after 12 years)
- reducing the use of raw materials
- regional roads, longer tracks with heavy trucks
- no more noise reduction than 2 - 3 dB needed
- based on a SMA 8
- more porosity than conventional SMA (up to 8-9 %), but less than TSL or porous asphalt

results on regional road sections – TSL and AO SMA – 80 km/h





## NEMO – surface designs to reduce vehicle emissions

- urban and peri-urban solution
- low noise pavement
- with lower *rolling resistance* to reduce exhaust emissions
- retention of tyre/road wear *microplastics* in the porous structure

### Noise and Emissions **MO**nitoring and radical mitigation

NEMO will create and test a completely new remote sensing technology that can measure noise and emissions from individual road vehicles and trains in real time.

**Innovative infrastructure-based solutions are developed to mitigate noise and emissions of passing vehicles.**



[www.nemo-cities.eu](http://www.nemo-cities.eu)

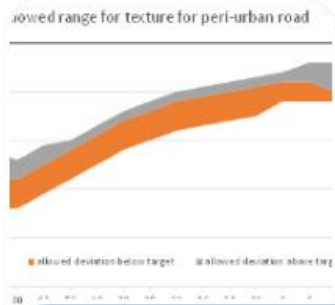
May 2020 – 2023



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°880441.



# NEMO low emission asphalt – step by step approach



## Design

- Definition of intrinsic targets:
  - Texture
  - Porosity
  - Sound absorption

## Laboratory testing

- 7 batches of slabs and asphalt samples

## Selection of the mixtures

- Rolling noise prediction model (SPERON)
  - Tyre vibrations
  - Airflow related mechanisms
  - Tyre friction
  - Tyre cavity noise
  - Aerodynamic vehicle noise

## Proving ground testing

- Fatigue carousel at the facilities of Gustav Eiffel (Nantes)
- Pilot Firenze

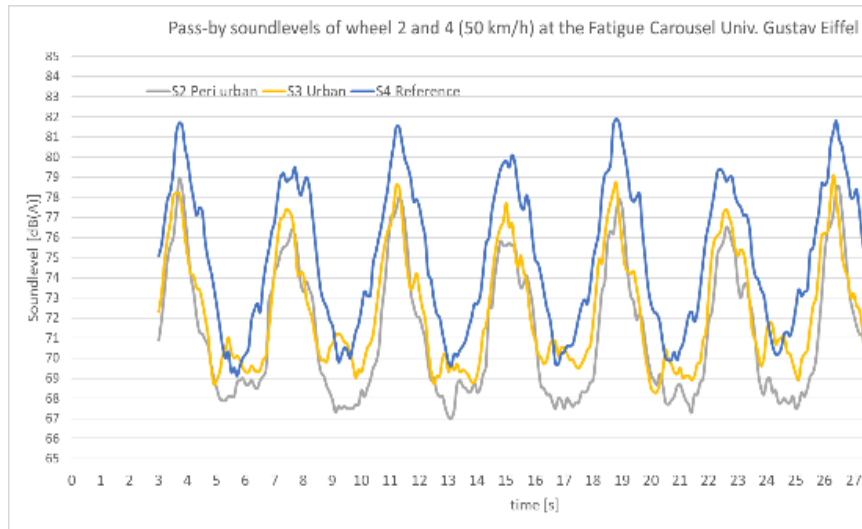




# Results NEMO (proving ground)



Mixture	Target	Noise reduction [dB]	
		50 km/h	70 km/h
Urban	-2,0 @50 km/h	2,2	4,2
Peri-urban	-3,5 @80 km/h	3,4	6,4



## Fatigue Carousel

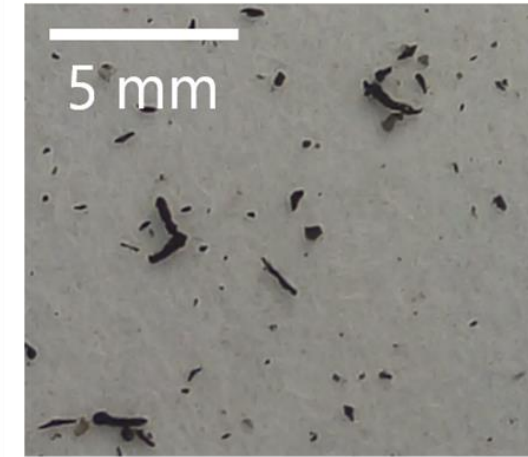
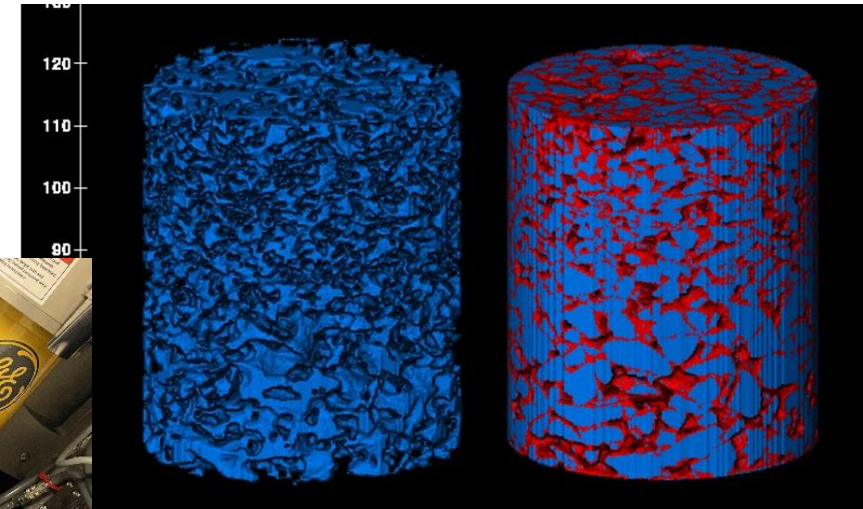
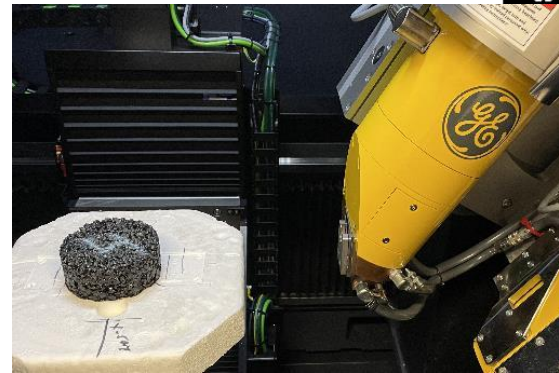
- initial situation
- after 200k runs @ 50 km/h
- after 1000k runs @ 70 km/h



## Results NEMO (pilot Florence and microplastics)

- PILOT Florence
- 3 dB noise reduction relative to a newly laid standard pavement
- Via G.B. Foggini in Florence

- research on Tyre Road Wear Particles in porous asphalt
- XRT-scans







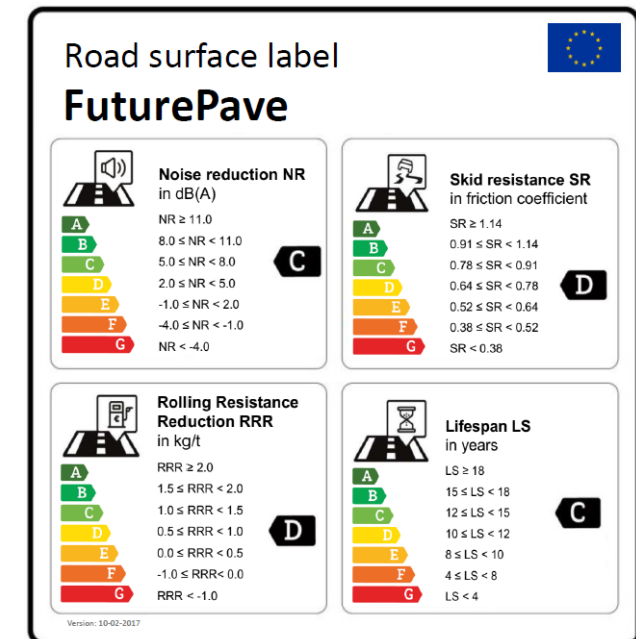
## Conclusions & recommendations

### Low noise road surfaces

- are a successful measure on Dutch motorways for 20+ years
- in urban areas: less porosity, more texture optimisation
- NEMO project has delivered a new State-of-the-Art example

### Keep up with modern time

- recycling / circularity
  - more and more surfaces constructed with recycled material  
→ think 15 years ahead
  - be careful with additives: fibres, modified bitumen, etc.
- rolling resistance
- tyre/road wear





**Thank you!**

**M+P**

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**NEMO project**

[www.nemo-cities.eu](http://www.nemo-cities.eu)

<https://www.linkedin.com/showcase/nemo-cities>



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