



Rijkswaterstaat
Ministerie van Infrastructuur en Milieu



Noise reducing pavements in the Netherlands

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TOPICS

1. History of silent pavements in NL
2. Current state of practice
3. Ongoing developments and innovations



History of silent pavements

- Porous Asphalt (PA) developed during 2nd World War in UK for air fields for safe landing and take off
- In 1971 PA rediscovered in NL, first test site on a provincial road in 1972
- Since 1987 limited application of PA for safety
- 1989: first Two-layer PA (TLPA) test site in the NL

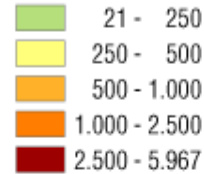


The Netherlands

- Area: 41.526 km², 20% is water
- population: 17 million
- Densely populated: 491 people/km² (2010) (USA:32)
- Concentrated in the south-west

Bevolkingsdichtheid 2010
per gemeente

Aantal inwoners per km²

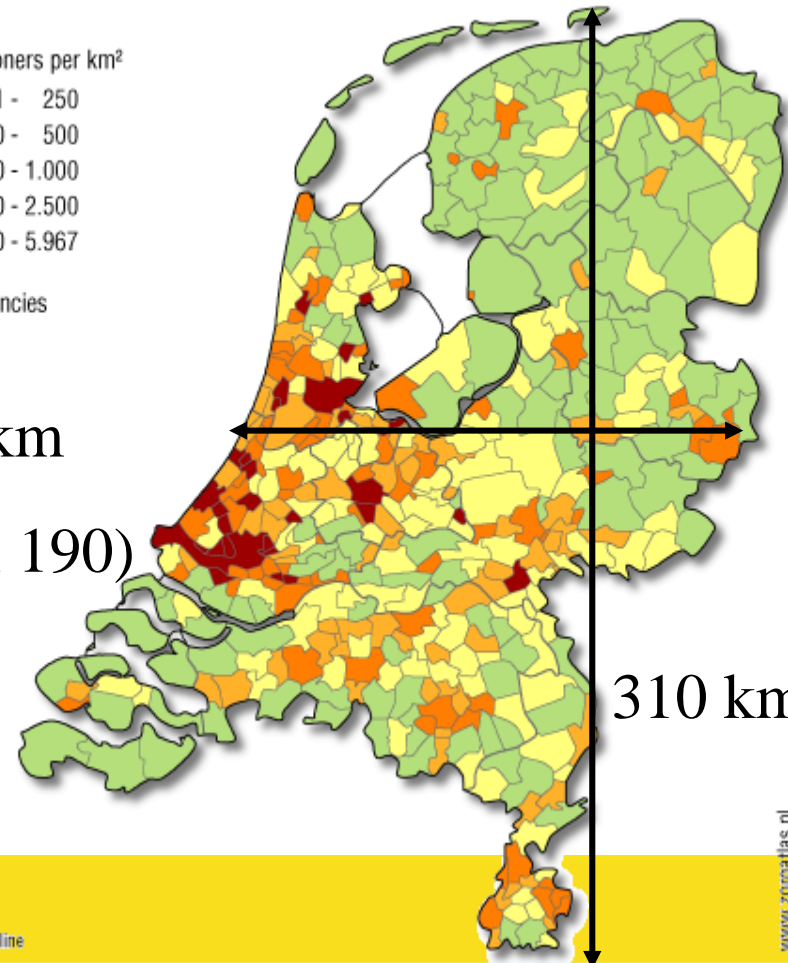


— provincies

175 km

(max 190)

310 km





Gemiddeld aantal voertuigen op werkdagen in 2010

< 5.000 voertuigen

5.000 - 10.000

10.000 - 20.000

20.000 - 40.000

40.000 - 80.000

> 80.000

Onzekere meetwaarden

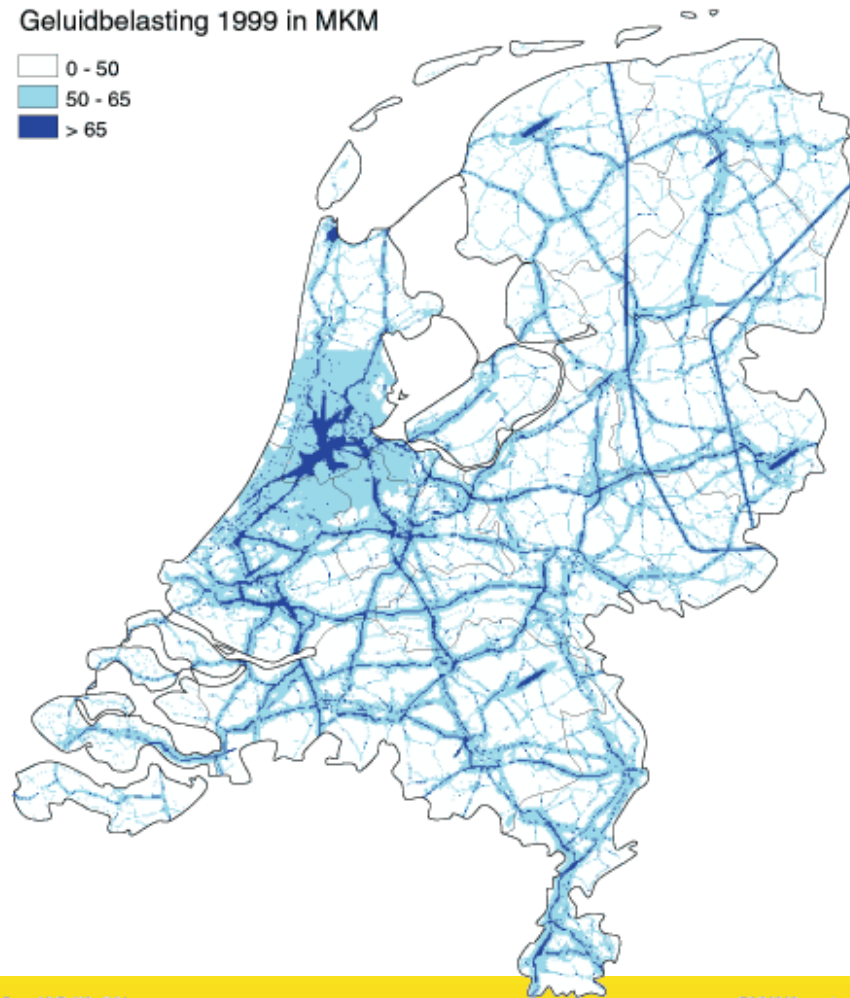


The Netherlands

- Area: 41.526 km², 20% is water
- population: 17 million
- Densely populated: 491 people/km² (2010) (USA:32)
- Concentrated in the south-west
- High traffic levels

Densely populated & high intensities

- Noise levels around highways are high
- Noise reducing wearing courses are cost effective compared to screens
- PA used on Dutch highways since 1987, first for safety, but that changed late 80's





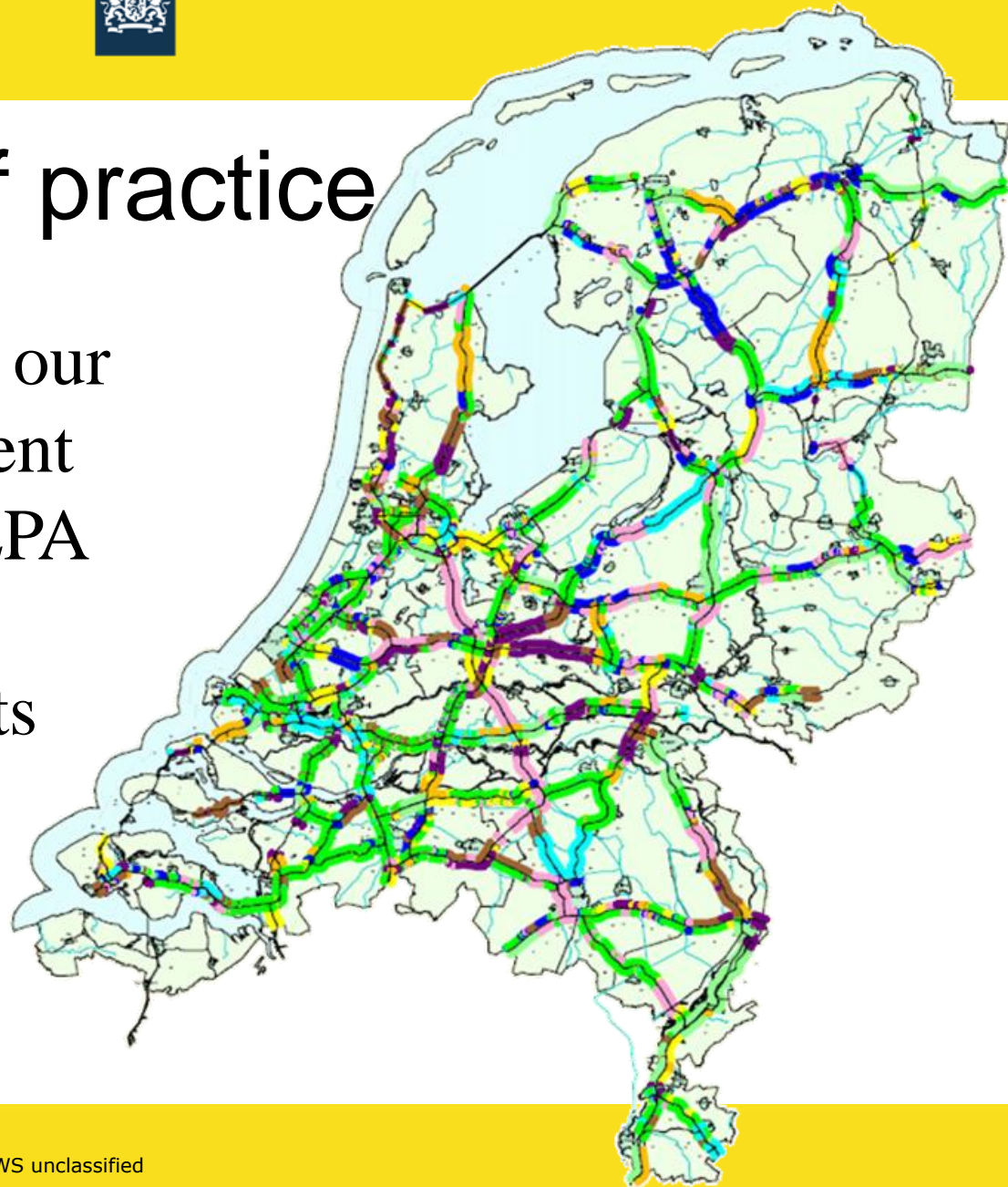
History of silent pavements

- In 1990 the policy changed: PA became the standard wearing course for highways (reason: noise reduction)
- 2006: PA+, more bitumen, longer life time
- 2007: TLPA allowed on motorways if cost-effective
- 2009: first PoroElasticRoadSurface (PERS) test site
- 2010: PA test sites with rejuvenators and steel fibers
- 2015: about 89% of our motorways have silent pavements, 70% SLPA and 18% TLPA, 1% thin silent pavements



Current state of practice

- 2015: about 89% of our motorways have silent pavements, 70% SLPA and 18% TLPA, 1% thin silent pavements





Current state of practice

Mix composition PA16

Standard PA consists of the components:

- crushed quarry rock 6 to 16 mm (PSV >58)
- crushed sand between 2 and 0.063 mm
- filler < 0.063 mm containing 25% $\text{Ca}(\text{OH})_2$
- pen grade bitumen 70/100 (PMB's are not used!)
- no RAP allowed



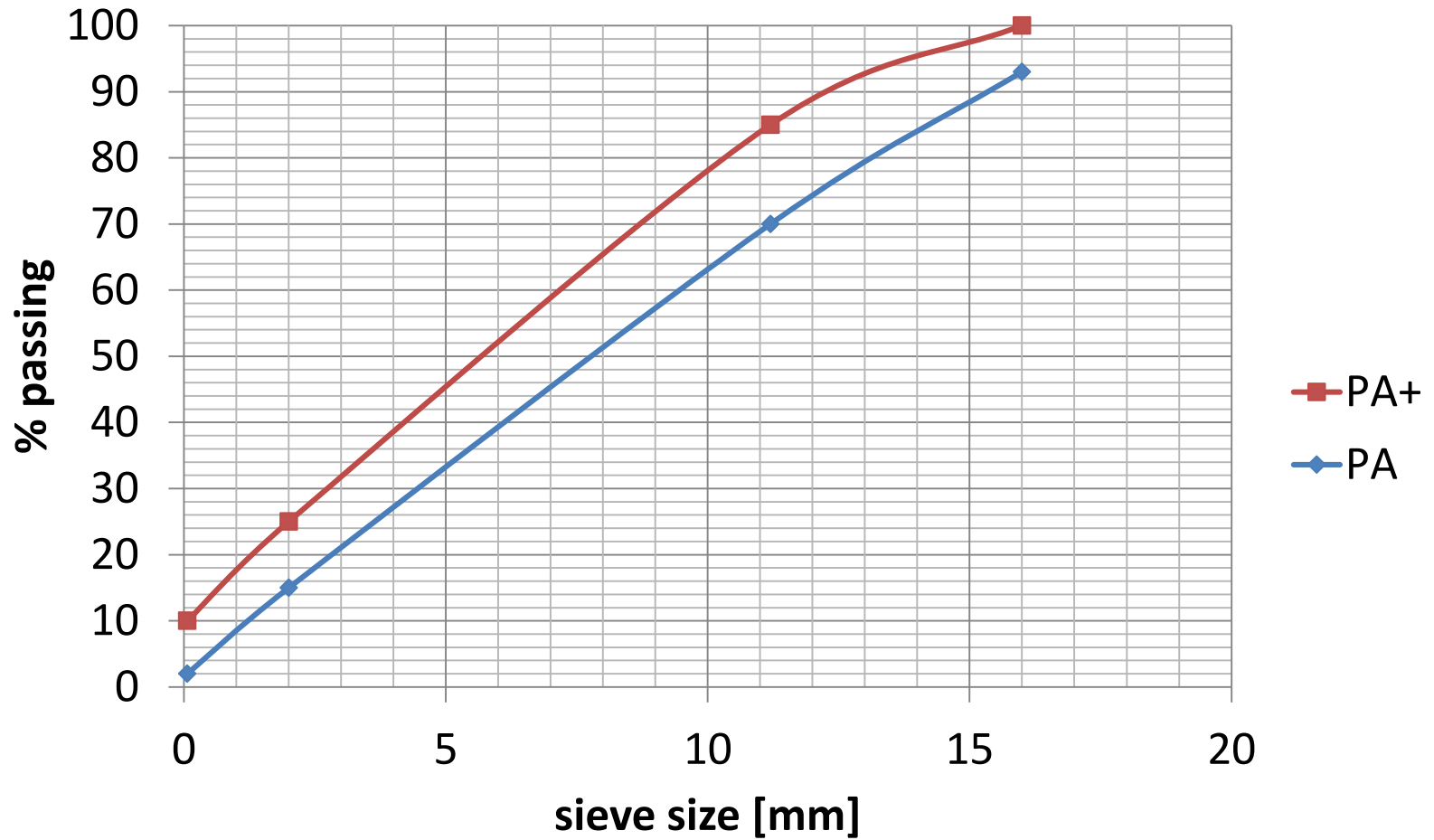
Current state of practice

Mix composition of PA 16 and PA16+

passing sieve	aim	min.	max.
16.0 mm		93	100
11.2 mm		70	85
2.0 mm		15	25
0.5 mm		DV	DV
0.063 mm		2	10
Bitumen 70/100 , PA	4.2	(%m/m in 100% mix)	
Bitumen 70/100 , PA+	4.5	""	
Void content		20%	

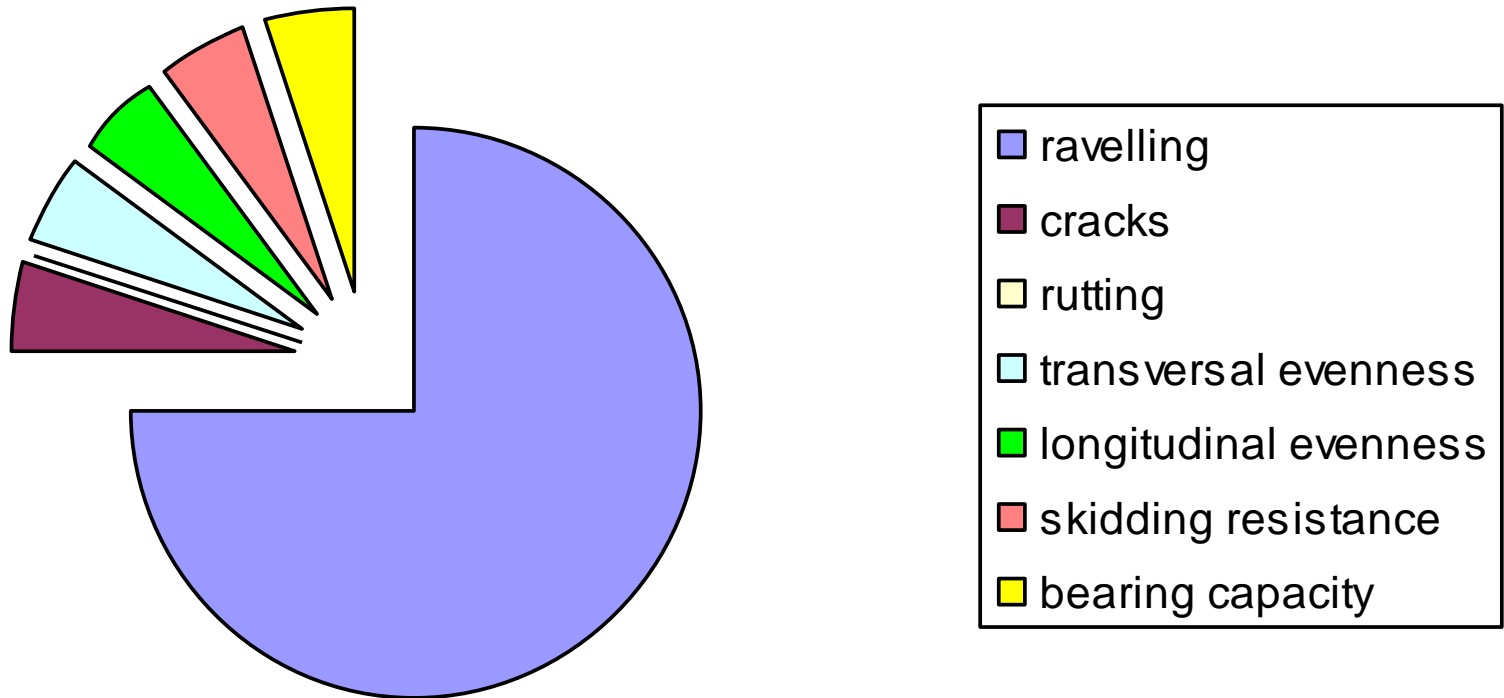
PA16+ also contains a drainage inhibitor (fibers or PMB)

Grading PA16(+)





Damage pattern of PA 16





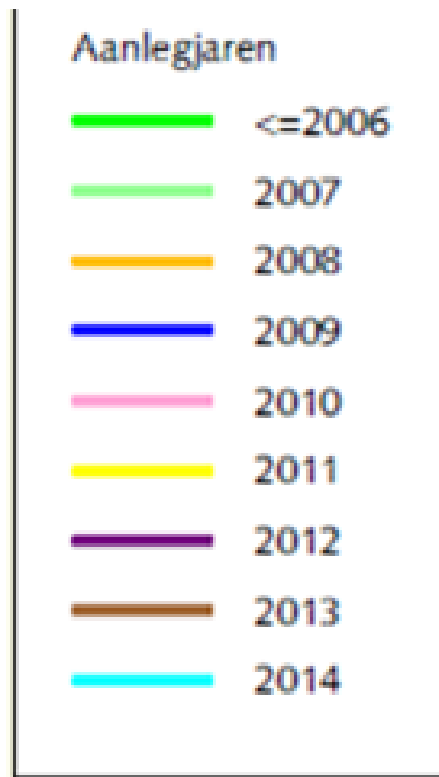
Current state of practice

mix	Right hand lane years	Other lanes years
PA	10	15
PA+	11	17
TLPA	9	13
TLPA-fine	8	12 (exp.)





Current state of practice





Performance of standard PA16

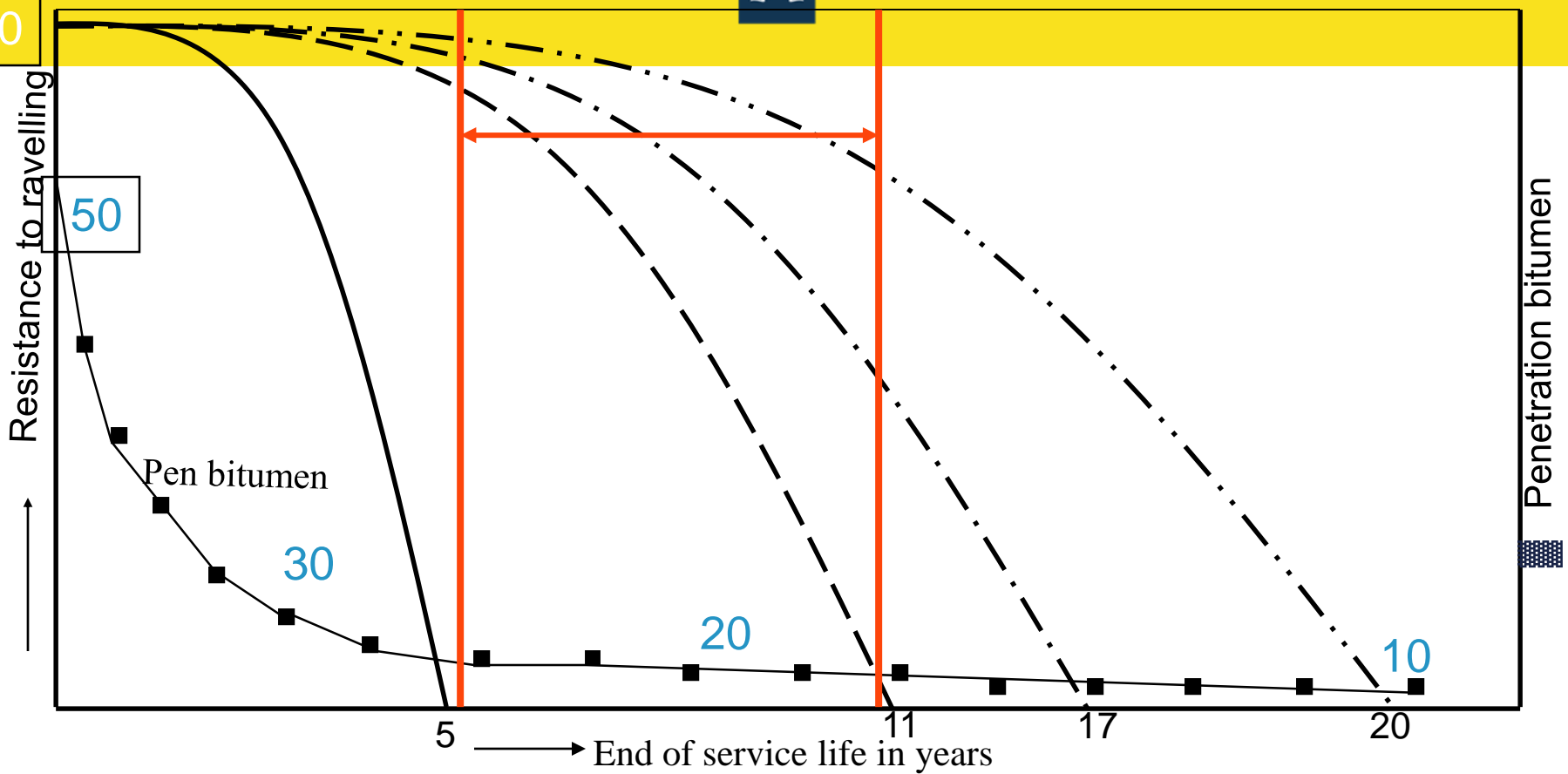
Noise reduction of PA measured with SPB for noise classification system called Ci:

- Single-layer PA16 is - 4 dB(A)
- Two-layer PA8 is - 6 dB(A)

Note: the reference mix in the Netherlands is Dense Asphalt Concrete

- decrease of noise reduction of single layer PA is about - 0.2 dB(A) per year
- decrease of noise reduction of two-layer PA is about - 0.33 dB(A) per year

Performance model for PA+



- Ravelling resistance in curves
- - - Ravelling resistance of slow lane
- . - . Ravelling resistance of fast lane
- · · Ravelling resistance of emergency lane

Between the red lines the ravelling process really takes place (slow lane)



Current state of practice

- Initially only one maintenance option: mill and replace
- New developments past decade:
 - Thin inlays
 - OESA: open emulsion sand asphalt
 - rejuvenators



Process

Spraying a “Rejuvenating binder” on the PA surface to rebalance the bitumen composition, strengthen the mortar bonding bridges and heal the micro cracks in the mortar.





Spraying rejuvenator on Porous Asphalt

• Lane width →



Bitumen emulsion containing a rejuvenator is sprayed on the PA surface



Aged PA after cleaning



Covered stones after spraying rejuvenator



Improve early life skid resistance by sanding

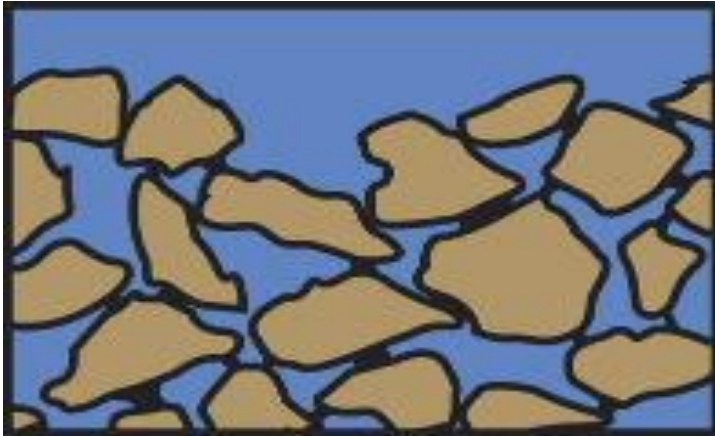


Spraying rejuvenator on Porous Asphalt

- application just before raveling starts
- Good skid resistance of PA before application is needed
- Always post-laying treatment with sand
- 3 to 4 years profit
- Also good experiences with Two-layer PA



Open Emulsion Sand Asphalt mixture



- Apply when there is limited loss of stones from the surface

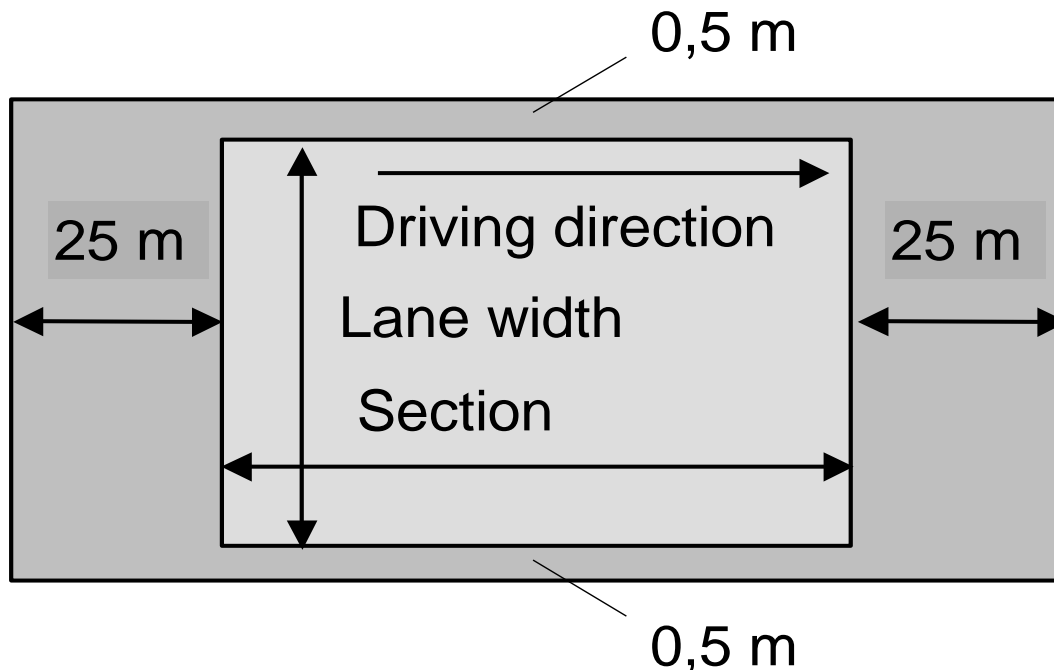


- filling holes and voids in situ with an Open Emulsion Sand Asphalt mixture



Thin inlay: mill&replace + rejuvenation

- Mill top 2 to 3cm existing PA
- Spray rejuvenator
- Place thin top layer (TLPA)
- Prevent ravelling on the edges of the surrounding old PA



	Replacement PA
	Sealing old PA





Thin inlay: mill&replace + rejuvenation

- Mill top 2 to 3cm existing PA
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No rollers
on existing PA



When which technique?

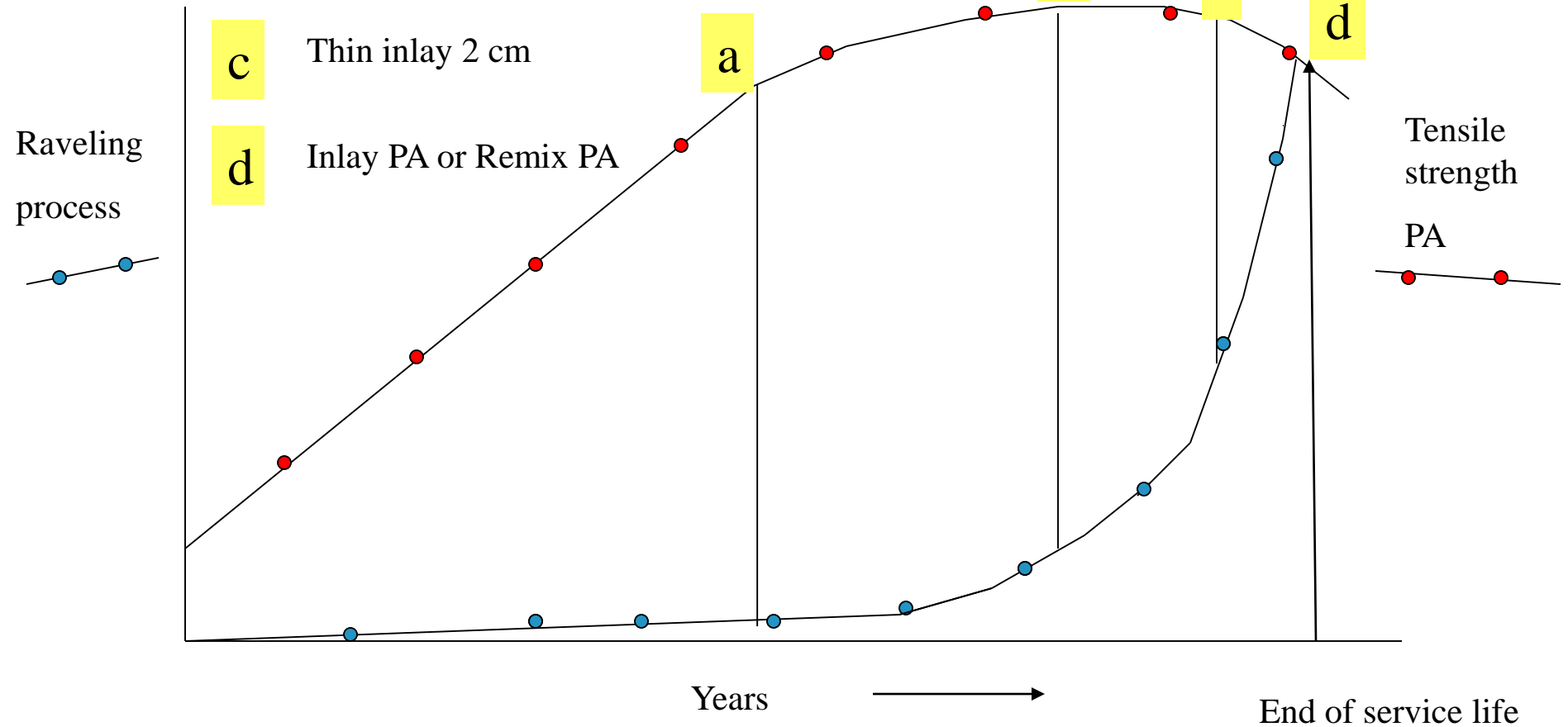


a Spraying rejuvenators (preventive maintenance method)

b Open Emulsion Sand Asphalt mixture (voids content 25%)

c Thin inlay 2 cm

d Inlay PA or Remix PA





Ongoing developments

- Evaluation of TLPA-fine: more noise reduction
- Evaluation of steel fibre PA: heal micro cracks using induction
- Evaluation of rejuvenators as preventive maintenance: currently 3 years, possibly more
- Innovation project: poro-elastic wearing course, aim is -10dB and 10 years life span

