Guidelines for silent roads in NL

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Message

Silent pavements are more costly than conventional pavements, but they mostly are the cheapest traffic noise mitigation measure!
Audio demonstration of tyre pavement noise

- **Dense Asphalt Concrete ("reference")**: 0 dB(A)
- **Thin Silent Surfacing**: -4 to -5 dB(A)
- **2-layer Porous Asphalt**: -6 dB(A)
- **Ultra silent rubber pavement**: -8 dB(A)
- **Normal tyre**: -6 dB(A)
- **Silent tyre**: -2 dB(A)

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Contents

- Overview of silent pavement types
- Dutch acoustical characterisation
- What is (not) applicable
- How to choose the right type and product; service life expectancy
- Boundary conditions for construction, e.g. season, crossings, etc
- Maintenance?
- Type of construction contract?
Overview silent pavements

• Silent asphalt
  – Porous Asphalt (PA)
  – 2-layer PA (2PA)
  – Silent Thin Surfacings (STS)
  – (SMA)

• Silent block pavements

• Silent PCC
  – Porous Concrete
  – Optimised texture

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Choice of (silent) pavement (1)

- Choice between asphalt, concrete or blocks mostly for conventional reasons (subgrade settlements, cables and ducts, traffic speed, looks)
- Asphalt generally more silent than concrete or blocks
- Choice of pavement influences traffic speed, hence traffic noise (10 km/h faster => 1 to 3 dB more noise)
Choice of (silent) pavement (2)

• What is needed/desired acoustically?
  – Traffic: cars/trucks, speed

• What is technically possible (durable)?
  – Torsion, (clogging)

• What is economically feasible?
  – Service life, cost comparison with noise barriers or insulation of houses
## Choice of (silent) pavement (3)

<table>
<thead>
<tr>
<th>Type of road</th>
<th>Max. speed (km/h)</th>
<th>Porous Asphalt (PA)</th>
<th>2-layer Porous Asphalt (2PA)</th>
<th>Texture optimised cement concrete (TOCC)</th>
<th>Silent thin surfacing (STS)</th>
<th>Silent block paving (SBP)</th>
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How to get a silent road?

- **1:** improve texture
- **2:** reduce flow resistance
- **3:** add acoustic absorption
- **4:** 'tune' absorption

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<th>Frequency [Hz]</th>
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<th>400</th>
<th>315</th>
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<th>125</th>
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**LAmax:**
- 80 km/h passage level at 7.5 m [dB(A)]
Acoustic characterisation in NL

“Cwegdek” = noise reduction when new, relative to “reference”

- average over 5 sections
- noise reduction measured by SPB at 5(!) m height
- “reference” is table of SPB-values, based on DAC 0/16 en 0/11 (1-2 years old)
- different vehicle types and speeds
- both “pavement types” and individual products
C_wegdek cars
C_wegdek trucks

The diagram shows the relationship between noise level (C_wegdek) and speed (snelheid) for various types of road surfaces. The x-axis represents speed in km/h, while the y-axis represents noise level in dB(A).

Key elements include:
- Gewone elementen (niet keper)
- Keperverband
- Dunne deklagen A
- Dunne deklagen B
- Fijngebezemd beton
- Uitgeborsteld beton
- Oppervlakbewerking

The graph compares different road materials and coatings, such as SMA 0/6 (SMA-NL 5), ZOAB 16, 2L ZOAB fijn (2/6), and 2L ZOAB (4/8), showing how they affect noise levels at various speeds.
Choice of (silent) pavement (1)

- Porous pavements (>20% voids)
  - Only >70 km/h (cleaning effect of car tyres)
  - Not with heavy pollution
  - Critical under torsional traffic
  - Take care of drainage and weed growth

- STS (Silent Thin Surfacings)
  - Critical with heavy pollution
  - Critical under torsional traffic
Expectancy of service life

- NB! Strongly dependant on traffic (type, loads, speed, torsion), conditions and construction quality

<table>
<thead>
<tr>
<th>Pavement type</th>
<th>Technical</th>
<th>Acoustical</th>
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</thead>
<tbody>
<tr>
<td>PA (motorways)</td>
<td>7-16 (11)</td>
<td>same?</td>
</tr>
<tr>
<td>2PA (&gt;70 km/h)</td>
<td>5-10 (7)</td>
<td>same?</td>
</tr>
<tr>
<td>STS</td>
<td>5-15? (8?)</td>
<td>??????</td>
</tr>
<tr>
<td>SMA</td>
<td>15-25</td>
<td>same?</td>
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</tbody>
</table>
STS: service life, noise and porosity

Service life [years] vs. Void content

- Service life
- Noise reduction

NB! General estimates only, exceptions exist

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Acoustical deterioration over time

Thin Silent Surfacings (STS)

- New
- 2 years old
- 5 years old

Noise reduction, cars 50 km/h [dB(A)]

# sections [•]

- > 5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 2.5
- 0.5 - 1
- 0 - 0.5
- < 0

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Acoustical deterioration over time

![Graph showing sound level (SPB) in dB(A) over time for different surface layers: silent block pavement, double layered porous asphalt, and dense asphalt concrete. The x-axis represents the time of the measurement in years, ranging from 0 to 6. The y-axis represents the sound level (SPB) in dB(A), ranging from 60 to 70.]
“Effective noise reduction”

- dB(A)
- +2
- 0
- -4
- time
- 8 yr? or 0,5*Tconv
- Tconv ca. 16 yr?

- conventional
- “reference
- example STS
Aoustical deterioration over time

- initially high noise reduction does not imply largest deterioration (noise increase)!

![Graph showing acoustical deterioration over time](image-url)
Acoustical deterioration over time

• Reasons for acoustical deterioration
  – Hardly texture related, acoustical effects of ravelling are small at 6mm nominal aggregate size
  – acoustical deterioration mostly related to absorption characteristics (“clogging” of pores, but cleaning does not help for STS)
Clogging of STS

Blue: near side wheel path

Red: between wheel paths
Durability silent asphalt

- Wet friction
  - polishing-resistant aggregate (high PSV)
- Rutting
  - gap graded stone skeleton (and polymer modified bitumen)
- ravelling
  - polymer bitumen
  - good aggregate
  - high porosity

Silent asphalt on roundabout??

NO!
Meetvakken CROW

- Tweelaags ZOAB
  - 7 vakken
  - 2/4 en 4/8 toplaag
  - aanleg 1993 – 1999
  - monitoring 2001 – 2006

- Dunne Geluidreducerende Deklagen (DGD)
  - 9 vakken
  - 4 producten
  - aanleg 2003 – 2004
  - monitoring 2004 – heden
Stroefheid Tweelaags ZOAB

- Nr 3: rafeling-corrigerende maatregel in 2004
- NB! grote verschillen in ouderdom
Textuur Tweelaags ZOAB

- Nr 3: rafeling-corrigerende maatregel in 2004
- NB! grote verschillen in ouderdom
Stroefheid (RAW 150) dunne deklagen, rechter wielspoor

- Seizoensinvloed
- Grote spreiding binnen product
- Verschil tussen “jaargangen”, wijzigingen in product?
Textuurb DGD
Points of attention: Design

- Avoid manual laying!
- SMA where torsion (crossroads, entrances & exits, along parking lanes)
- “Soft” transverse joints (changing mix ‘on the fly’)
- Quality underlying structure !!
  - Assessment and analysis (bearing capacity, cracks, ravelling, unevenness, potholes, ..), necessary repairs
- Also renew binder layer(?)
- Noisy foreign objects (e.g. bridge joints, manhole covers, road markings)
Points of attention: Construction

• Preparation old pavement
  – Repairs
  – Tack coat
• Low heat capacity
• Weather conditions!
• Continuous production and supply
• Joints
• (Manual laying, if any)
• Initial friction (wet & dry)
Aandachtspunten kwaliteitscontrole

- Functionele eigenschappen
- Zo weinig mogelijk of geen boorkernen
- Geen eis verdichtingsgraad
  - referentiedichtheid
  - Verbrijzeling
- Wel eisen HR ("conform ontwerp")?
- Samenstelling (hopper monsters) conform opgave?
- Steenslag
- Hechting?
Points of attention: Management and Maintenance

• Management:
  – Extra attention for winter maintenance (de-icing)
  – Monitoring of noise reduction?

• Maintenance for acoustical reasons?
  – Boosting of noise reduction (yet??) impossible (cleaning has no effect)

• Maintenance for technical reasons
  – Extension of service life or local repairs (still??) very difficult
  – Renew wearing course (and binder too?!)
Recyclability

• A challenge in the future to recycle single-sized RAP with PMB, especially in new (silent) wearing courses....

(But we will cross that bridge when we come to it ....)
Contracts (1)

• Make explicit requirements for noise reduction
  – SMART: specific, measurable, acceptable, realistic, time-dependant
  – For relevant traffic type and speed
  – Preferably based on acceptance testing
  – Not only initial reduction, but also after time (e.g. 2-3 years)
  – BE REALISTIC, both in dB and in years
Contracts (2)

- Requirements for initial friction (wet & dry)
- Innovative contracts?
  - In principle possibility for clear division of responsibilities, but:
  - Little experience with long term performance, so realistic (fair) requirements are still difficult
  - Legal formulation of warranty conditions
  - Legal risks larger than technical risks?
Checklist applicability
Silent Pavements (1)

- **Design**
  - quality of underlying structure
  - desired noise reduction (traffic type and speed!)
  - drainage
  - friction
  - durability
    - traffic intensity
    - torsion
  - (no) manual laying
Checklist applicability
Silent Pavements (2)

• Construction
  – planning / season
  – preparation old pavement (repairs)
  – initial friction (wet & dry)
  – durability

• Management and maintenance
  – noise reduction and drainage
  – winter maintenance (de-icing)
  – durability
Conclusions

• Silent pavement often the most cost effective noise mitigation solution, but:

• Be realistic!

• Take into account:
  – Noise increase over time
  – Shorter technical service life (than trad. pav.)
  – Construction is critical (design, planning)
  – Higher construction costs (than trad. pav.)
  – Higher maintenance costs (than trad. pav.)
Message

Silent pavements are more costly than conventional pavements, but they mostly are the cheapest traffic noise mitigation measure!
Thank you for your attention!

Questions?

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• STS not applicable without strengthening!
• and why should you?
• STS not applicable without strengthening!
• and why should you?
• Width problem remains!