Road surface characteristics and tyre road noise

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www.bast.de
Main Goals of the German Ministry of Transport

• Mitigation of road traffic noise at the source (Tyre Road Noise)
• Today about 4% of the cost of constructing a new road is for noise mitigation
BASt* Experience:

- Sperenberg Project
- Leiser Straßenverkehr 1
- Leiser Straßenverkehr 2
- Silence (EU Project)
- Michelstadt (New ISO surface)
- Several test sites in highways
- Tyre Road Noise Study (FEHRL**)

*Federal Highway Research Institute
**Forum of Highway Research Laboratories
Sperenberg Project:

Truck Tyre Noise vs. Aggregat Size (Coast By 70 km/h)

Little influence of the texture on the noise

dB(A)
90
85
80
75
70
65
60

68,4 68,2 73,2 73 73 72,5 73,2

OPA 4/8+11/16 OPA 4/8 SMA 0/8 GA m. AS SMA 0/11 GA m. AS GA m. AS

porous dense
Passenger car coast by noise level at 80 km/h vs. aggregat size

<table>
<thead>
<tr>
<th>Material</th>
<th>dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPA 4/8 + 11/16</td>
<td>67.9</td>
</tr>
<tr>
<td>OPA 4/8</td>
<td>69.6</td>
</tr>
<tr>
<td>SMA 0/8</td>
<td>74.2</td>
</tr>
<tr>
<td>GA m. AS 2/3</td>
<td>75.0</td>
</tr>
<tr>
<td>SMA 0/11</td>
<td>76.1</td>
</tr>
<tr>
<td>GA m. AS 2/5</td>
<td>76.5</td>
</tr>
<tr>
<td>GA m. AS 5/8</td>
<td>77.5</td>
</tr>
</tbody>
</table>

The graph shows a trend indicating an increase in noise level with increasing aggregat size.
Plateau with gaps for dense surfaces

- Reduction of tyre profile vibrations
- Minimisation of air pumping
Dense Surfaces

Stone Mastix Asphalt with chipping size 0/8 is the major road surface type in the German primary road network.

This surface type has in average a -2 dB(A) tyre noise level compared to a reference surface.
Pourous Asphalts

Systematic construction and testing began in Germany in 1986.

5 generations of porous asphalt:
- Increase in void content 15 ---> 22 Vol.-%  
- Increase of acoustic effectiveness  
- Increase of durability by polymer modified binders  
- Twinlay: top 8 mm, bottom 16 mm aggregate size  
- Appliance of Nano Technology to avoid clogging
Porous Asphalt

Advantages:
• Reduction of splash and spray
• High resistance to rutting
• Highest acoustic effectiveness [-7 to - 9 dB(A)]

Disadvantages:
• Higher cost (+30 €/m²)
• Repairing problems and higher maintenance costs
• Reduced durability (clogging, ravelling, binder hardening)
• Bad wet grip short after construction
## Effectiveness of Porous Asphalt

<table>
<thead>
<tr>
<th>Generation</th>
<th>Date of Construction</th>
<th>SPB Noise 120 km/h Pass.Car</th>
<th>SPB Noise 90 km/h Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1988</td>
<td>79</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>1993</td>
<td>78</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>1997</td>
<td>76</td>
<td>84</td>
</tr>
<tr>
<td>4 (Twinlay)</td>
<td>1998</td>
<td>77</td>
<td>82</td>
</tr>
<tr>
<td>5 (increased thickness)</td>
<td>2003</td>
<td>76</td>
<td>-</td>
</tr>
</tbody>
</table>
Acoustical Mode of Function of Porous Layers

Absorption $\alpha$

Frequency [Hz]

1 Layer

2 Layer
Construction of Twinlay
Surface Ruination

Ravelling

Clogging
Porous Surfaces

Only used in “noise hot spots” in the German primary road network

Only about 2% of the 12,000 km long Autobahn network consists in porous asphalt

Porous concrete surfaces are also possible to construct, but too many open problems
Tyre development in “Leiser Strassenverkehr 1”

Pass. car at 80 km/h coast by concrete

-1,3 dB*

-1,7 dB**

Series tyres

Tyres with reinforced side wall

SMA

Concrete
Noise emission level between 2 and 6 o clock is dominated by trucks.

Heavy truck traffic is dominant between 2 and 6 o clock (ca. 60%).

One truck each 8 sec.
Truck drive axle tyres are about 3-4 dB(A) louder than steering axle tyres.

Drive axle tyres of different brands vary up to 4 dB(A) on dense surfaces and 1.5 dB(A) on porous surfaces.

Source: DWW (NL) measured on Sperenberg surfaces, 70 km/h.
Truck drive axle tyres are about 3-4 dB(A) louder than steering axle tyres.

Drive axle tyres of different brands vary up to 4 dB(A) on dense surfaces and 1.5 dB(A) on porous surfaces.

Source: DWW (NL) measured on Sperenberg surfaces, 70 km/h.
For truck drive axle tyres a noise reduction of 3 dB(A) seem to be possible without changing other tyre features too much.

This is reached only by the profile design, no changes in carcass or rubber mixture.

(Source: Leiser Straßenverkehr 2)
Future Tyre Road Noise Research of BASt
Tyre Pavement Interaction Test Facility
Gluing of the road surfaces into the caskets

Preheat of the caskets

140° C hot polymer modified bitumen
Thank you for your attention!