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Low-noise road surfaces



Noise from road traffic – a common problem

About 8.5 % of the urban population in the EU indicate that they are seriously annoyed by traffic noise¹. Unfortunately, nuisance is not the only adverse effect of traffic noise. It causes a variety of health problems including stress, sleep disturbance, and heart disease. Recently the World Health Organisation estimated that at least one million healthy life years are lost every year from traffic related noise in the western part of Europe with 1.8 % of ischemic heart disease solely due to traffic noise².

1. For conurbations with 50,000 inhabitants and more, see “Burden of disease from environmental noise, Quantification of healthy life years lost in Europe”, World Health Organization Regional Office for Europe, WHO, Copenhagen (2011)

2. “Burden of disease from environmental noise, Quantification of healthy life years lost in Europe”, World Health Organization Regional Office for Europe, WHO, Copenhagen (2011)

Where does road traffic noise come from?

Motor vehicles, like cars, buses, vans and trucks, produce several types of noise when operating, which all contribute to the total noise emission of the vehicle. There is the noise generated by the engine, by the tyres interacting with the road surface, by the exhaust, by the air inlet and by the cooling fan as well as aerodynamic noise.

For cars the level of the tyre/road noise equals the total level of the other noise sources at speeds between 30 and 40 km/h, becoming more and more predominant with increasing speed. For heavy vehicles this breakeven speed is a bit higher, typically between 50 and 60 km/h³.

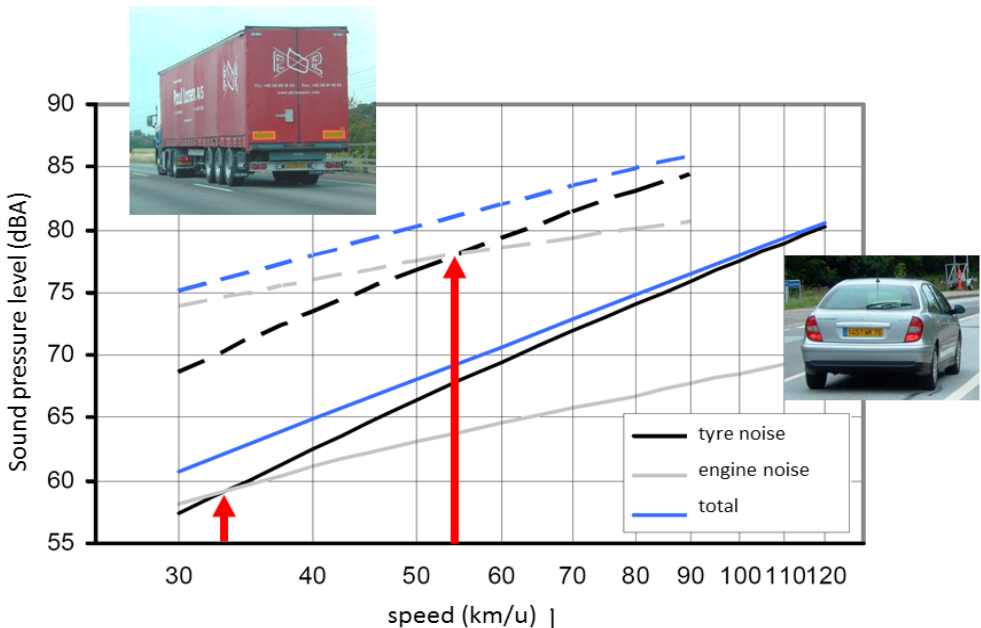


Figure 1: Tyre/road noise versus speed for cars and heavy vehicles

Even in streets with low speeds, such as in built-up areas, it is desirable to reduce tyre/road noise, especially for cars. This applies even more – and also to heavy vehicles – on medium to high speed roads.

3. Sandberg, U.; Ejsmont, J.A. "Tyre/Road Noise Reference Book", INFORMEX, SE 59040 Kisa, Sweden (2002) (www.informex.info)

What can be done about tyre/road noise?

Source-related measures reduce noise at its origin, while transmission-related measures try to block the transmission path between the noise source, for instance the tyre and the road surface, and the receiver, meaning people nearby. Source-related measures include low-noise road surfaces, quieter tyres and speed reduction. Transmission-related measures include noise screens and facade insulation.

What can public authorities do?

Public authorities can change speed limits and road surfaces. Lowering speed limits typically reduces noise by 2 – 3 decibel for a speed reduction of 20 km/h at speeds equal or lower than 50 km/h. At higher speeds the reduction decreases. They can also improve traffic safety but may increase travel times.

While the acoustic properties of tyres are the subject of European regulation⁴, road surfaces are the exclusive responsibility of local and national road administrations. Numerous European cities⁵ have tested quiet road surfaces over recent decades. The life span of low noise pavements, too short in the past, has much improved.

4. EC Regulation No. 661/2009

5. e.g. Amsterdam, Brussels, Copenhagen, Gothenburg, Paris, Rotterdam and Turin.

Why use quiet road surfaces?

- They are cost effective in the majority of cases (also see below on the financial benefits of low-noise road surfaces).
- They generally require a lower investment than noise screens or facade insulation.
- They have a noise reducing effect beyond a relatively small zone such as the first row(s) of dwellings along a road, as is the case for noise screens, and beyond the inside of a dwelling, as is the case for facade insulation.
- They reduce noise irrespectively of weather conditions, whereas wind and temperature can make noise screens less effective or even ineffective.
- They can improve traffic safety by reducing splash and spray in the rain (porous asphalt).
- They improve perceived acoustic quality, even when the measured noise reduction is limited: a low-noise road surface sounds better.

What are the disadvantages?

- The noise abatement potential of quiet road surfaces is generally lower than with noise screens or facade insulation.
- There is a trade-off between the noise reduction and the lifetime of the upper layer of the asphalt, the wearing course.
- Not all low-noise road surfaces can be applied everywhere.
- Porous asphalt is more difficult to maintain in winter.
- Low noise-road surfaces tend to lose their noise reducing capacity during their lifetime. However, they remain a quieter solution, as conventional wearing courses like dense asphalt concrete (DAC) are already noisier when new and also tend to become noisier over time.

What are their strengths and weaknesses?⁶

1. Thin surface layers

These are also called 'thin asphalt layers' or 'thin noise reducing asphalt road surfaces'



Figure 2: A thin surface layer

They use a small maximum aggregate size to obtain an optimised texture that minimises tyre vibrations. Their layers are up to 3 cm thick. There are many different types of thin surface layers on the market, for instance over forty in the Netherlands, including porous and dense types. They typically reduce noise by 2-4 decibel at 50 km/h for cars with respect to average dense asphalt concrete⁷. Porous asphalt types are about 1 decibel quieter on average than dense ones, but they have a shorter life span than dense asphalt. The typical lifetime of a thin surface layer is seven to nine years. The most common problems are ravelling (loss of aggregates from the surface) and de-bonding from the underlying layer.

6. Eijbersen, M.J., e.a. "Stille wegdekken", Publicatie 287, Ede (2010), www.crow.nl

7. DAC 0/16; see excel sheet with Cwegdek values which can be downloaded from www.stillerverkeer.nl



Figure 3: Heavy raveling of a thin surface layer

Thin surface layers are hardly more expensive (typically about 10%) than dense asphalt concrete. They are more sustainable, as less material is needed to produce them but they need a high quality tack coat that resists shearing forces. Thin surface layers are suitable and increasingly popular on low and medium speed roads but they are not suitable for sites that are subject to severe shearing forces, such as roundabouts, steep slopes, bends, lorry exits, etc.⁸

2. Single-layer porous asphalt

Porous asphalt is a bituminous wearing course that contains coarse aggregate of a single size (typically 14 or 16 mm), which forms a 'stony skeleton'. As porous asphalt has no sand fraction and only a limited amount of mastic, it is characterised by a high amount of interconnected voids between its aggregates, typically 20–25 %. These voids form irregular channels absorbing part of the acoustic energy, thereby reducing noise by 1 to 3 decibels compared to average dense asphalt concrete. Single layer porous asphalt is about 4 cm thick. It is suitable for high speed roads but not for low and medium speed roads. The voids tend to clog quickly on these roads, increasing noise again by 1 decibel or more per year. On high speed roads this effect is limited to about 0.3 dB(A) per year, thanks to the self-cleaning effect in rainy weather.

8. Comprehensive information about thin surface layers can be found in Kragh, J. e.a., OPTHINAL Final Report (2011). The report can be downloaded at http://www.brrc.be/pdf/15/doc/OPTHINAL_FinalReport.pdf

3. Two-layer porous asphalt

Two-layer porous asphalt consists of a 2.5 cm thick top layer incorporating a small aggregate size (2/4; 2/6 or 2/8) and a 4.5 cm thick bottom layer with a coarse aggregate size. This brings the total thickness of the porous layer to 7 cm that absorbs more noise, initially about 5 to 7 decibels. Two-layer porous asphalt is relatively expensive and suitable for high speed roads that require exceptional noise reduction. It is vulnerable to ravelling, due to the small size of the aggregate in the top layer, and to clogging, similar to single-layer porous asphalt.



Figure 4: Two layer porous asphalt

4. Stone mastic asphalt 0/6

Stone mastic asphalt has a thin, 3 cm surface layer with a specific mix design. It contains more mastic than thin surface layers, which fills the space between the aggregates. Since SMA 0/6 is not porous, it does not absorb noise as much but it is more robust than other asphalts. A test with SMA 0/5 conducted in Berlin resulted in an initial noise reduction of 1,5 dB.

What do low-noise road surfaces cost?

Low-noise road surfaces are more expensive than conventional dense asphalt concrete. They cost roughly 10% more for thin asphalt layers and up to 200 % more for two-layer porous asphalt. However, costs for other noise abatement measures are reduced.

What about trucks? Don't they wear out the asphalt even faster?

In 2011 the city of Rotterdam started a test with two types of asphalt (a durable type and low-noise type) that are more suitable for roads carrying heavy goods traffic⁹. The first results (2011,2012) indicate that these asphalts (thin layer and stone mastic asphalt) are promising in terms of durability and noise reductions. An update of the website and the results can be expected in 2015.

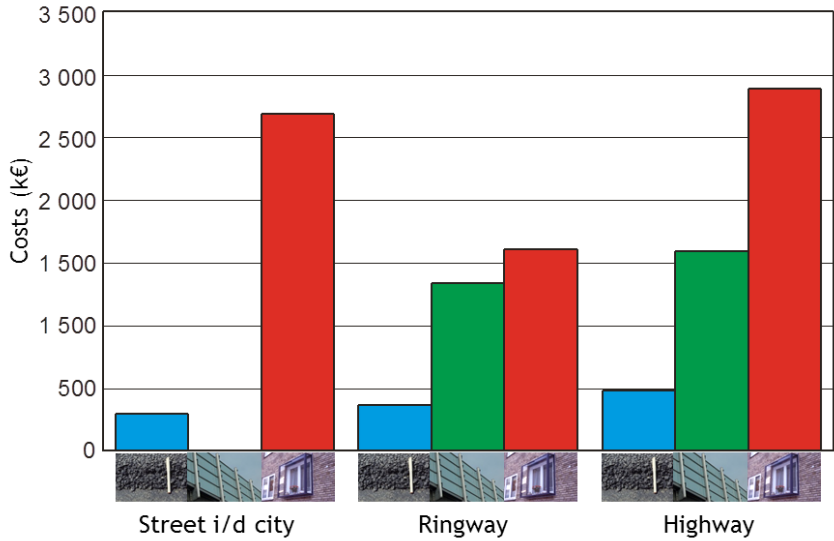
What is cheaper? Quiet road surfaces or other measures?

This depends on the individual case. When there is only a single house in the wide vicinity of a road, facade insulation can be an efficient solution. In many cases, however, low-noise road surfaces are better, including from a financial point of view. For instance, Danish researchers compared the costs of treating 1 km of road in a city, 1 km of a ring road and 1 km of a motorway with three different noise abatement measures: two-layer porous asphalt, a noise screen, and facade insulation. Both the total investment costs over a period of thirty years and the costs per decibel noise reduction were by far the lowest with the two-layer porous asphalt¹⁰.

9. For more information, see www.kenniscentrumgeluid.nl

10. Ellebjerg, L.L.; Bendtsen, H. "Costs and perceived noise reduction of porous asphalt pavements", Proceedings of the 2001 International Congress and Exhibition on Noise Control Engineering (INTERNOISE 2001), The Hague, The Netherlands (2001)

Cost per km 'treated' way



Costs/dB(A)/house

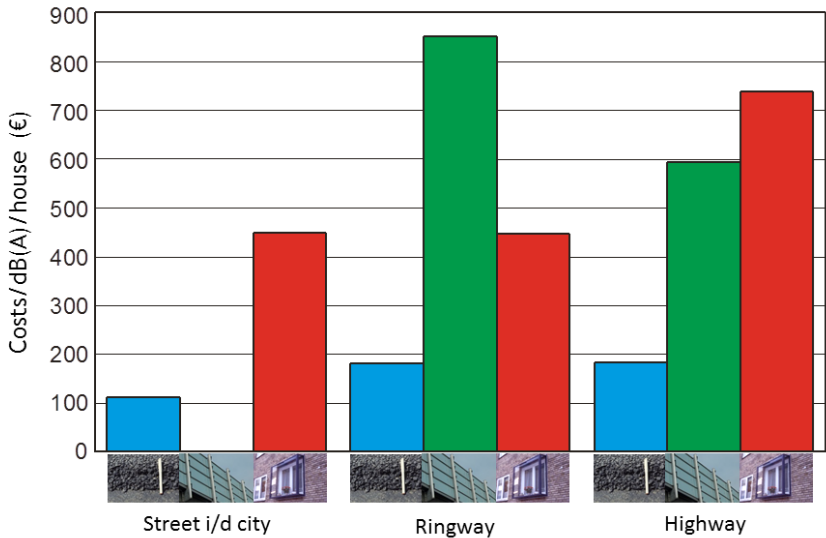


Figure 5: Costs of three noise abatement measures for three typical cases



Figure 6: Test section with poroelastic road surface in Kalvehave (Denmark)

Existing low-noise road surfaces optimised texture (thin surface layers) or absorption parameters (single-layer porous asphalt), or both (two-layer porous asphalt). Future quiet road surfaces could potentially improve on elasticity. Research shows that that road surfaces with an elasticity comparable to that of a tyre can yield a noise reduction of 10 decibels and more. The EU funded project PERSUADE¹¹ currently examines the characteristics of poro-elastic road surfaces containing a significant fraction of rubber and an elastic resin as binder. A national Dutch project was started in January 2014.

This type of road surface may be market ready in about five to ten years and could then significantly reduce road traffic noise.



Figure 7: Poroelastic road surface. The dark particles are rubber granulates

11. www.persuadeproject.eu



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Publisher: EUROCITIES

Text: Luc Goubert

Layout:

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www.eurocities.eu

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Brussels, 15 May 2015