噪声污染是健康和个体幸福的一大威胁。这一事实已经在许多专家和研究机构的报告中得到证实。最近，世界卫生组织发布了一份关于环境噪声对健康影响的报告（2011年3月）。欧洲大部分地区的人口面临着交通噪声导致的高噪声水平的影响。这种噪声会带来干扰、睡眠紊乱、健康问题、学习困难、大量健康寿命年失（DALY）以及甚至死亡。为了减少交通噪声，需要在地方和国家层面采取许多措施。在地方层面，降噪路面代表了减少交通噪声的首选解决方案，特别是在城市环境中，它通常比其他降噪措施（如噪音屏障或立面隔热）更具成本效益。

自2011年秋季以来，鹿特丹市启动了一个项目，使用特别设计用于重型车辆的安静沥青。已经铺设了一些测试段，并将在未来几年内进行监测。这本小册子为那些想了解降噪路表面在城市情况下的益处和常见问题的人提供了一个简短的介绍。

**Policy**

欧盟委员会将环境噪声视为欧洲的主要环境问题之一。减少交通噪声是欧盟国家政策的一个日益重要的优先事项，特别是在欧洲噪声指令2002/49/EC下。欧盟

This leaflet gives a short introduction for those who wants to explore the benefits and common pitfalls of silent road surfaces in urban situations.

The European Commission addressed environmental noise as one of the main environmental problems in Europe. Reduction of traffic noise is an increasing priority in the policy of European countries, not in the least by the European Noise Directive 2002/49/EC. The EU
members states are imposed to produce noise maps and action plans regarding environmental noise.

In many action plans silent road surfaces are the most effective and cost efficient measure in the abatement of environmental noise. However, history has learned that a silent road surface is a type of surface that only can be applied with specific knowledge about design, laying process and maintenance procedures. Therefore it is important to know the relevant aspects of application of these surfaces.

Noise reducing road surfaces

The acoustic emission of modern passenger cars is dominated by the noise of the rolling tyres. Only under conditions of strong acceleration or speeds below 30 km/h propulsion noise can dominate. Also for heavy duty vehicles at speeds above 60 km/h, rolling noise starts to become the major source. Rolling noise is influenced by the properties of the road surface like surface texture, acoustical absorption and aero-dynamical processes (air-pumping). Improving the surface properties in such a way that the efficiency of the noise generating and amplifying processes are reduced will result in a lower rolling noise level.

There are several types of silent road surfaces and their application are mainly determined by the featured noise reduction, the allowable traffic speed, the composition of the traffic flow and the possible wrenching of tyres on the surface due to parking movements. For urban situations three surface types are commonly applied:

A. Thin Surface Layers
B. Stone Mastic Asphalt
C. (Double-layered) Porous Asphalt

Monitoring the acoustical effect

To optimise the performance management of silent roads it is advisable to implement a monitoring program to determine the change of acoustic effect in the lifetime. Managers and decision makers get a synoptic overview of the acoustical effects after implementing their silent road policy. It is recommended to compare the findings of the monitoring with the acoustic effect of a conventional road surface. A study like a monitoring programme provides insight into the long-term effects of low noise road surfaces. These insights allow well-founded choices to be made in terms of durable solutions to noise problems.
Economical aspects (costs and benefits)

A silent road surface is more expensive to lay most of the time and also more expensive to maintain than a conventional surface. At the same time the expected life time of a silent road surface is shorter. Its cost efficiency can only be proved by comparing these costs to those of conventional noise measures (noise screens or facade insulation). Although silent road surfaces are expensive they are most of the time the cheapest noise reduction measure.

The following aspects had be taken also in amount with regard to silent road surfaces:

- For porous layers the durability of the sidewalk drainage is an extra aspect for attention. Periodically cleaning or extra precautions can be expensive;
- The contribution of porous layers to the bearing capacity of the pavement construction is relatively small, so strengthening can be necessary;
- Almost all silent road surfaces are not adequately resistant to wrenching tyres and therefore not a suitable application for crossings, roundabouts etc. The general rule is: more reduction means more voids, and thus a shorter service life.

Management and maintenance

The laying of a silent road surface is a critical process. Extra restrictions considering lay out, weather conditions and skill of the asphalt laying team have to be taken into account. The dry and wet skid resistance will vary in the first period after laying and low values can be measured, so warning of the road users is essential.

Processes that can negatively influence the acoustic degradation of low noise road surfaces are loss of stones, ravelling and the reduction of absorption (for open-graded mixes). Particularly in urban environments road surfaces are very sensitive to these types
Drainage or porous asphalt shares its stone skeleton with SMA, but due to the lower amount of mortar, holes are not closed, but form open channels through the material. The porosity gives the road surface good absorptive properties. The noise suppressing effect is maximal when the surface is smooth (by use of a fine fraction in the top layer) and the thickness is optimized so the acoustical absorption is maximal for reducing traffic noise. With this road surface, noise reductions of more than 4 dB can be achieved. But, this type of asphalt needs regular maintenance. Without maintenance the noise reduction performance drops rapidly. The durability of this asphalt is low, especially in urban circumstances. In suburban areas (ring roads for example) porous asphalt appears to be more suitable.

**Durability of the acoustical effect**

It is known that the surface properties which cause the acoustic reduction change in time. In almost all situations this lead to a decline of the noise suppressing capabilities. By lack of monitoring programmes, there is insufficient general knowledge of the material’s long-term behaviour with regard to civil engineering and acoustical properties. Most relevant processes are the roughening of surface texture due to stone loss in the surface and increasing of flow resistance due to clogging of the pores.

When conducting a study into acoustic properties over time, it is important to evaluate the road surface depending on the expected life. A conventional road surface such as dense asphalt concrete (DAC) or stone mastic asphalt (SMA), will show less acoustic degradation, but these surfaces have a significantly longer life. A quick decline in noise reduction for conventional road surfaces thus has a greater effect over the long term than for low noise road surfaces. The blue line is silent road surface and the red one conventional road surface. The dashed lines are the averaged life times.