

# SilVia – Sustainable Road Surfaces for Traffic Noise Control

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## Abstract

The overall aim of the project was to provide decision-makers with a tool allowing them to rationally plan traffic noise control measures including low-noise road surfaces. That tool, actually the final output from the project, is a “Guidance Manual for the Implementation of Low-Noise Road Surfaces”. It is a compilation of the key research and findings from the entire component Work Packages within the project.

The Manual is split into 6 parts. **Part 1** summarises the basics about noise in general and vehicle noise and tyre/road noise, in particular, in order to provide the reader with the necessary background to the topic. **Part 2** presents an overview of the different low-noise solutions for pavements, including well-established surface types and technologies which are relatively new or under development, some of which have been tested within the SilVia project. It also reviews construction and maintenance techniques used for low-noise surfaces and addresses the possibilities of improving the acoustic performance and durability of low-noise road surfaces. **Part 3** first summarises the different measurement methods that are available for the evaluation of the acoustic performance of a road surface, particularly for labelling and conformity-of-production (COP) assessment. The essential chapter in Part 3 is a presentation of the “Noise classification procedure” that has been developed to provide the most accurate and reproducible characterization of the acoustic performance of a specific pavement and could be used in specification and procurement. **Part 4** deals with the economic aspects related to the use of low-noise road surfaces. This includes consideration of both safety and sustainability issues. A cost/benefit analysis tool developed as part of this project is also presented. **Part 5** considers the interactions that can affect the effectiveness – positively or negatively – of low-noise surfaces. **Part 6** presents advice and recommendations derived from the study on how to make the best use of the low-noise solutions for road pavements. They address the decision makers, the road authorities, the contractors and road engineers as well as the policy makers at national and at European level.

In addition, a CD-ROM is attached to the Guidance Manual. It includes all main outputs (Deliverables) of SilVia as well as the intermediate technical reports produced by the different Work Packages, plus some other related documents. This is for the reader who is interested in technical details and in the research results underlying the development of the different chapters of the Guidance Manual.

## **1. Introduction**

Recent estimates indicate that more than 30% of EU citizens are exposed to road traffic noise levels above that viewed acceptable by the World Health Organisation (WHO) and that about 10% of the population report severe sleep disturbance because of transport noise at night [1]. In addition to the general disruption of activities and quality of life, there are additional adverse health and financial effects. According to OECD [2], the threshold of annoyance is 55 dB(A) in terms of average traffic noise level outside and the threshold of unacceptability is only 10 dB(A) higher: 65 dB(A). Now, the difference in vehicle noise emission between a noisy and a silent road surface can be more than 10 dB(A), which means that the road surface alone could make the difference between a comfortably quiet road and a disturbingly noisy road. Low-noise road surfaces have been experimented for many years. It is a rather interesting way of reducing vehicle noise emission at the source. Several solutions have been developed that use either asphalt or cement or other materials. However, despite these advances, the use of these surfaces is not yet widespread even though they represent a rather inexpensive means of reducing traffic noise. There are several technical and implementation problems why there has been a lack of uptake in the use of low-noise surfaces. In the EU Green Paper on Future Noise Policy [3] published in 1996, the significant potential for road traffic noise reduction by use of special ‘low noise road surfaces’ was mentioned as a major issue. That is why the overall aim of the SilVia project (Sep 2002 – Aug 2005) is to provide decision-makers with a tool allowing them to rationally plan traffic noise control measures including low-noise road surfaces.

SilVia stands for Silenda Via, which can be translated from latin as “The road must be silent”. The real title is: “Sustainable Road Surfaces for Traffic Noise Control”. The final output of the project, the Guidance Manual [4], is a compilation of the key research and findings from all of the component Work Packages. This paper gives an overview of the contents of the Manual.

## **2. Basics about noise**

Part 1 of the Manual summarises the basics about noise in general and vehicle noise and tyre/road noise, in particular, in order to provide the reader with the necessary background to the topic.

One of the main factors that contribute to high levels of tyre/road noise is the surface “megatexture”. This characteristic is also responsible for a non-negligible extra fuel consumption due to rolling resistance, which means extra air pollution and in particular the production of additional greenhouse gases. Finally, contrary to common sense, low-noise surfaces do not need to be smooth and hence possibly slippery when wet; many road surface materials and techniques have proven to be relatively quiet as well as highly skid resistant.

Low-noise road surfaces were first experimented with over 40 years ago. Several solutions have been developed that use asphalt, concrete or other materials.

### **3. Low-noise technology for road surfaces**

Part 2 of the Manual presents an overview of the different low-noise solutions for pavements, including well-established surface types and technologies which are relatively new or under development, some of which have been tested within the SilVia project. It also reviews construction and maintenance techniques used for low-noise surfaces and addresses the possibilities of improving the acoustic performance and durability of low-noise road surfaces. The wider use of quieter road surfaces could without doubt improve the quality of life for a significant number of European citizens and at the same time improve perception of the quality of the highway infrastructure, particularly when experiencing improved comfort as a road user. These benefits can be achieved without affecting the safety performance of the road network; skid resistance will be preserved or even increased by some of the available solutions. Some low-noise surfaces are deemed to be much safer than ordinary dense ones because they improve visibility during wet weather by preventing water splash and spray and preserve skid resistance by draining rainwater away. Surfaces that reduce tyre/road noise emission also reduce the noise inside the cabin of cars (the opposite is not generally true), thus improving user comfort; potential secondary benefits from reducing interior noise include reduction of driver fatigue and improved environment for voice activated equipment. However, the subsequent increase in traffic speed is sometimes said to possibly affect the improvement in accident rates. This underlines the importance of considering each noise countermeasure in a holistic way so that overall the benefits and disadvantages are properly identified and rationalized during the planning and decision taking processes. This is the philosophy underlying this work.

Although modelling techniques for predicting sound emission and propagation models that incorporate the effects of distance, atmospheric sound absorption, meteorological influences (temperature and wind speed gradients) and ground attenuation, are becoming more advanced and increasingly accurate, there are still important methodological problems that require to be resolved for the effects of low-noise pavements to be accurately accounted for. The acoustic performance of a given pavement design cannot therefore be adequately assessed at present before the pavement is actually constructed on full scale. Only testing of the finished pavement, either by noise measurements of passing vehicles or using a noise measurement trailer, provides the necessary information about the noise reduction achieved. Furthermore, these methods lack the possibility of absolute calibration that would make the results exchangeable throughout Europe. Laboratory tests of small pavement samples are available but their results cannot be translated into an estimation of the noise reduction of a finished pavement in practice. Part of the solution is to establish or improve prediction models relating the pertinent road surface parameters, e.g. texture profile or acoustic absorption, to noise (or noise variation). This is addressed within the SilVia project. However establishing methods that allow the acoustic performance of a road surface to be assessed from small laboratory samples lies outside the scope of the SilVia project, falling instead within the competence of the road constructors.

## **4. Measurement and noise classification of road surfaces**

Part 3 of the Manual first summarises the different measurement methods that are available for the evaluation of the acoustic performance of a road surface, particularly for labelling and conformity-of-production (COP) assessment. One method is based on measurements of noise from vehicles selected from the traffic stream, and is therefore highly representative of actual traffic noise impacts. However, it is not applicable everywhere. Other methods produce a greater degree of reproducibility but are less representative as they do not measure a large number of vehicle/tyre combinations and/or only measure tyre noise. The review also includes methods for the determination of other important related parameters such as mechanical impedance and rolling resistance. A detailed description of these measurement methods is given in an appendix, including details of equations developed to allow the use of certain non-acoustic parameters for approximating acoustic performance. Another appendix describes proposed certification procedures that have been developed within the SilVia project for noise-related measurement equipment.

The essential chapter in Part 3 is a presentation of the “Noise classification procedure” that has been developed to provide the most accurate and reproducible characterization of the acoustic performance of a specific pavement. The procedure – with some variations – has different applications among which is the determination of the correction term for the road surface influence in the vehicle noise source model developed by the HARMONOISE project [5]. That project (Aug 2001 - Jan 2005) produced methods for the prediction of environmental noise levels caused by road and railway traffic. These methods are intended to become the harmonized methods for noise mapping in all EU Member States.

## **5. Cost-benefit analysis**

Noise control generally cannot be achieved without incurring some costs. The investment by manufacturers in achieving lower noise vehicles is already a substantial component of development costs and similarly, the cost of noise barriers and other highway and land use measures designed to reduce noise impacts is huge. Clearly, the use of the low-noise surfaces studied in this project may also attract costs over conventional approaches in terms of both total construction and maintenance costs. It is therefore important that the project should address the cost-benefit aspects of low-noise surfaces, considering the full lifecycle and comparing the cost and benefits of the potential noise reduction with the cost and benefits of noise reduction obtained by other measures. In this complex situation, particularly with respect to the technical solutions for traffic noise reduction, it is not obvious which of these solutions will provide the largest economical benefit. There is a need for a transparent procedure for cost-benefit analysis of noise mitigation measures, which offers comparison of the cost of construction and maintenance for the various measures.

Part 4 of the Manual deals with the economic aspects related to the use of low-noise road surfaces. This includes consideration of both safety and sustainability issues. A cost/benefit analysis tool developed as part of this project is presented. It describes a calculation procedure for determining the

cost/benefit ratio of noise control measures with a focus on low-noise surfaces, and includes a worked example. The method is provided as an EXCEL spreadsheet on the accompanying CD-ROM.

## **6. Interactions**

Low-noise pavements are often used in combination with noise barriers, earthworks and other measures without full understanding or control of their combined noise reduction performance. It is often assumed that the overall effects of individual measures may be added without taking into account the frequency dependence, which is different for each measure. When the computations are carried out properly it often appears that the efficiency of a low-noise pavement in the presence of a noise barrier is lower than the mere addition of the individual effectiveness of the pavement and the barrier. In addition, the frequency dependent attenuation during propagation over larger distances leads to a reduced effect of low-noise pavements at larger distances.

Part 5 of the Manual considers the interactions that can affect the effectiveness – positively or negatively – of low-noise surfaces. The environment or local conditions are important aspects to consider, e.g. the road layout (bends, slopes, roundabouts, crossings, etc.) and some characteristics of the traffic (percentage of heavy vehicles, speed, etc.). Other noise control measures can be used in conjunction with a low-noise surface like noise barriers, façade insulation and traffic management; it is important to know how they interact to be able to make rational use of those measures.

## **7. Advices and recommendations**

Part 6 of the Manual is a collection of advices and recommendations derived from the study on how to make the best use of the low-noise solutions for road pavements. They address the decision makers, the road authorities, the contractors, the road engineers as well as the policy makers at national and at European level. The Manual has been written taking into account the fact that it should ideally be possible to make use of the content without any particular expertise in the subject area. The main body of the text has therefore been drafted with the non-expert in mind. However, some detailed technical sections which are needed to implement some of the procedures recommended in the Manual, are attached as appendices. It is noted that the Manual does not reflect the total amount of information generated over the course of the project. Much of this extra information is offered on an attached CD-ROM. It contains all of the “Deliverables” and most of the intermediate, relevant technical reports produced by the SilVia Work Packages. The purpose is to provide interested readers, experts, academics, etc. with full access to the scientific and technical results of the project. As wide as possible dissemination is the basic SilVia Consortium's policy. Therefore, no intellectual property protection is foreseen neither for the results of this project nor for the background knowledge brought in or utilized in this project. So, the Guidance Manual as well as the documents on the CD-ROM are freely downloadable from the SilVia web site [6].

## 8. References

- [1] **European Environment Agency (2003)**. *Europe's environment: The third assessment*. EEA Environmental Assessment Report No. 10. EEA, Copenhagen, Denmark.
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- [4] **SilVia (2006)**. *Guidance Manual for the Implementation of Low-Noise Road Surfaces*. Report no. 2006/02, FEHRL, Brussels.
- [5] [www.imagine-project.org](http://www.imagine-project.org).
- [6] [www.trl.co.uk/silvia](http://www.trl.co.uk/silvia).

## 9. Acknowledgment

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