Road traffic noise reduction at the source an overview

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Abstract

Despite several measures to reduce traffic noise the overall noise level has risen on motorways by 4 dB and on rural roads by 2 dB from 1970 to 2002. Experts do expect an increase of traffic by 30% within the next years and thus consequently traffic noise will increase too. Essential part of various research projects therefore is to find and develop measures to reduce road traffic noise. The most efficient sustainable way is to reduce the noise at the source, which means to understand the noise generating processes at the interaction of vehicle tires and road surfaces. An overview is given about the research activities of the German research project “Leiser Strassenverkehr 2” (LeiStra2, Low noise road traffic 2).

Project concept

The project LeiStr 2 is made out of three parts with several sub projects.

1. Low noise tires
2. Low noise road surfaces
3. Result testing

Altogether there are 12 partners from science and industry collaborating in this project. The project will be terminated in the summer of 2009.

Low noise tires

It is well known, that the rolling noise of truck tires is a major source of the total road traffic noise. Furthermore we do learn from traffic count statistics, that truck noise dominates especially during night times. It is for these reasons, that a series of new truck tires for the steering wheel have been developed and optimized as part of the project LeiStra 2. CPB tests (controlled pass by) revealed that two of these new tires were even less noisy by more than 1 dB than the least noisy tire on the market. Other tire features are currently tested in long distance tests and if the new tires pass these tests with positive results, it is likely, that one of these new truck tires will be produced and brought to market.

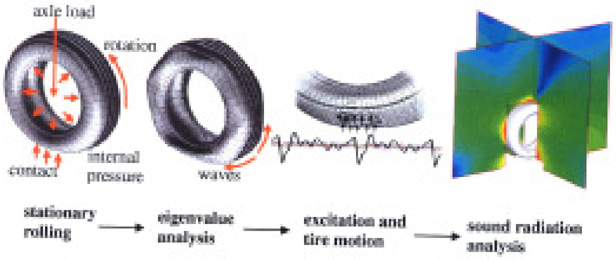

Figure 1: Finite Element Model of a tire emitting sound with realistic axis load, road contact, rotation, excitation due to road texture and sound emission.

The complexity of a tire makes the development of new tires very time consuming and expensive. In a further LeiStra 2 project a physically based finite element software (FEM) was developed, that is intended to be used to design tires and predict their performances, in particular their noise potential. Figure 1 is a sketch of the general procedure. Starting from a FEM of a real tire, composed out of various materials and layers, adding an axis load and rotation and make contact with the road surface as well introduce forces into the contact patch due to the road surface texture, an Eigenvalue analysis is performed and reveals the tire vibrations, which are used to calculate the emitted sound field. Figure 2 is an example showing surface displacements in red and blue at enhanced scale.

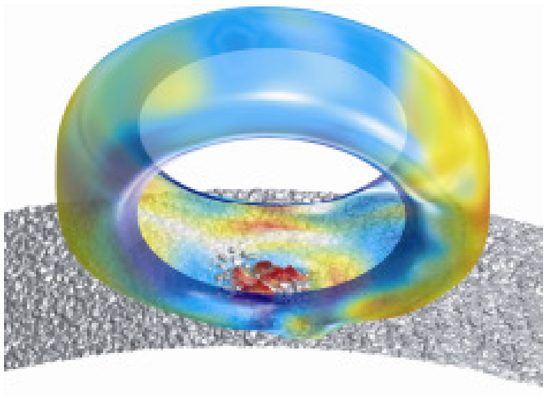

Figure 2: Surface displacements of rolling tire on road surface

The state of the art so far is, that the software displays the physics very well, even in small details, however, the amplitudes of the vibrations and thus the calculated sound pressures at higher frequencies are still too high, compared with measurements at real tires. Currently a more refined tire excitation and tire material model is introduced, which should improve the software.

Low noise road surfaces

Various asphalt technologies as well as exposed aggregate concrete are examined in this project. However, the main focus is laid on improving the abilities of open porous asphalt (OPA). This technology offers a substantial noise reduction of 5 dB and maybe more than that. However, the economic life time of an OPA is much shorter than for pavements made with conventional technologies. Main problem with OPA is that dirt gradually clogs up the pores and this reduces the sound absorbing abilities of the OPA in due course. Figure 3 shows a computer tomography picture of an OPA probe. With this technique the void contents is measured to high accuracy, which is typically about 24% for a new OPA, and it is also possible to distinguish between bitumen, grains and dirt.

In order to extend the life time of an OPA it is thus necessary to prevent the OPA from clogging up. To this aim a principle from nature is adopted. Certain polymer nano particles can make a surface either hydrophilic or hydrophobic. The latter is known as the Lotus effect.

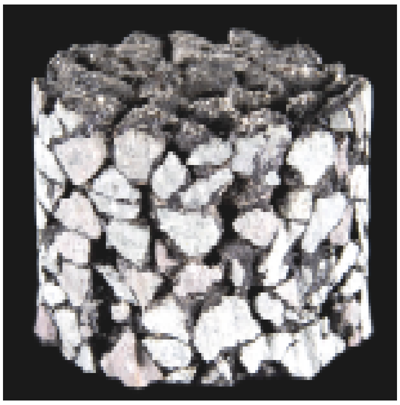

Figure 3: Computer tomography picture of an OPA sample

Polymer Lotus effect paint was used to cover the surface of the voids of an OPA. In other tests a certain block copolymer was added to the bitumen and thus making the surface of the voids more hydrophilic. Both measures do show some promising trends, however, they still have to proof to be practicable in terms of road engineering and durability of the OPA. Although first intensive testing revealed, that dirt particles penetrating into an OPA modified in such a way have less tendency to stick to the surface of the voids and can be washed out more easily, than with conventional non modified OPA, there is still quite a bit of research necessary to make this an advantages road surface. In addition to these efforts several procedures and technologies to clean a clogged up OPA are tried. These investigations are still in progress.

In another sub project an older idea has been adopted. Attempts are in progress to integrate Helmholtz resonators in an OPA. While the main idea is simple, severe problem arise in order to find a solution that also pleases the road engineers and guarantees a durable product. There is a chance, that this measure will be successful and if so it offers another about 3 dB noise reduction.

Of particular annoyance is the noise originating from tires rolling over expansion joints connecting roads with bridges.

Figure 4: expansion joint

Our test expansion joint made from five lamella segments is shown in figure 4. The current legislation is, that these segments have to be inserted 5 mm lower than the road surface. If the segments, however, would be inserted flush with the road surface, the noise level could be lowered by several dB. Furthermore, if specially developed surface elements are fixed on top of the lamella segments, the noise level can be lowered even more. Finally choosing different surface texture of these additional elements it is possible to do some sound design and thus make the resulting noise at least a little bit more acceptable.

Result testing

Within LeiStra 2 several roads with various different technologies and surfaces were built and are tested under real traffic condition and load. Apart from some progress with improving open porous asphalt the most prominent finding is, that a new stone mastix asphalt could be developed and build, where a noise level was measured with the statistical pass by method (SPB), that is again lower than the noise level for other so called low noise asphalt surfaces, see figure 5. This new stone mastix asphalt surface offers a noise reduction of 4dB with respect to the reference surface.

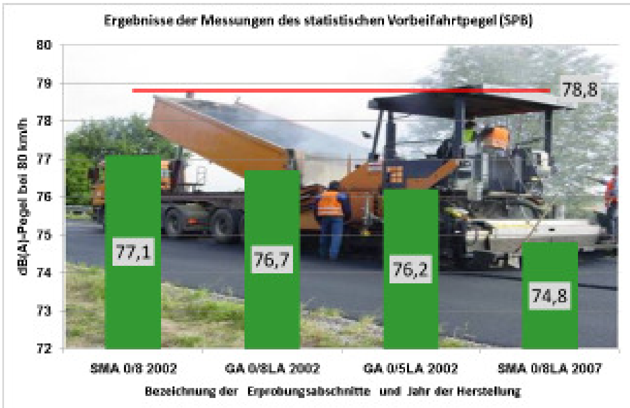

Figure 5: SPB noise level for various asphalt surfaces

The testing of new road surfaces will be continued until summer 2009 and the findings will be documented and communicated in due course.

Further information

Further information about the various project partners and results can be obtained at http://www.LeiStra2.de

Acknowledgment

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