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Development of an acoustically optimized multi-layer surface-system based on synthetics

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ABSTRACT

To facilitate modern economies, the development of society and the extension of economic areas the traffic sector plays a leading role by supplying a technically functioning, efficient and environmentally compatible infrastructure. Due to the increase of transportation processes, especially the commercial transport, the mode of transport "road" is of great importance in this regard. However, this causes a steadily increasing exposure of the population to traffic-induced emissions – especially noise emissions have received more attention in recent years! Public infrastructure construction is subjected to numerous attempts aiming to standardize the tasks as well as the limitation of costs. The result has been that the innovation potential, especially in regard to designs limiting traffic noise, has not been made use of sufficiently. Furthermore, the performance limit of conventional materials has almost been reached which is why this research project developed and designed a completely new surface-material concept based on synthetic materials. The surface-system was designed to exhibit the highest possible acoustically favorable properties, was verified by examinations in the Vehicle-Pavement Interaction Facility of the Federal Highway Research Institute (BASt) and was constructed in-situ. The focus of the project was the development of a multi-layered wearing course system with a synthetic top layer, representing optimized texture-properties and a synthetically-bound bottom layer functioning as an absorption layer. In addition to the acoustic efficacy of such a wearing course system, the structural feasibility as well as the durability of the concept are subjects of the analysis. Over all the concept shows a level difference of tire-road noise of more than 8 dB (A) regardless of the speed – this is almost a half of the perceived volume.

The presented results are converted into further development steps to facilitate transfer of the idea into a marketable product. This further development is carried out within the framework of the research project "Fundamental research on polymer materials and innovative production and installation technologies for road surface layer systems (INNO PAVE)" funded by the Federal Ministry of the Education and Research. In addition to the RWTH Aachen University, represented by the Chair and Institute of Highway Engineering Aachen, an interdisciplinary team from science, research and industry is involved in this further development, which will be finalized in 2018. The described work symbolizes the initial basis for this.

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Contents

1. Introduction

The efficiency and availability of the German road infrastructure is of central economic and social importance. A well-developed and efficient transport infrastructure is a basic requirement for an appropriate mobility of people and goods. It is a key factor for the outstanding economic development in Germany in recent decades. It forms the basis for the employment and prosperity of our society today. The Road infrastructure plays an important role in this area due to the strong transport performance in the area of commercial freight transport: 84% of freight traffic volume (in tonnes) and 72 % of traffic performance (in tonnes per kilometre) are handled by road (see Fig. 1). As a result, traffic-induced emissions such as pollutants (i.e., carbon monoxide or nitrogen oxides) or traffic noise are increased by the environmental impacts. This requires extensive investment!

Particularly traffic noise (tire road noise as well as engine and flow noise) becomes an increasing problem for our population. Traffic noise is not only annoying, but also harmful to health. Already today, about 60% of the German population suffers from socially and physically impaired noise pollution. According to a representative survey conducted by the Federal Ministry in cooperation with the German Federal Environmental Agency up to 16% of the population are exposed to noise levels that reach a high level of health risk. Noise affects the communication and relaxation of the people, disrupts sleep (especially the deep sleep phase), causes concentration difficulties, creates anxiety and fear associations and leads to stress symptoms such as greatly increased blood pressure and accelerated heart rate. In the worst cases this can lead to a cardiovascular system: hypertension, arteriosclerosis or heart attacks (Umweltbundesamt, 2013; Griefahn et al., 2007; Hellbrück, 2010).

Since the 1990s, we have been trying to solve traffic noise problems sustainably through increased investment in noise reducing systems. However, the extensive standardization as well as the strong focus on economic aspects (low costs),

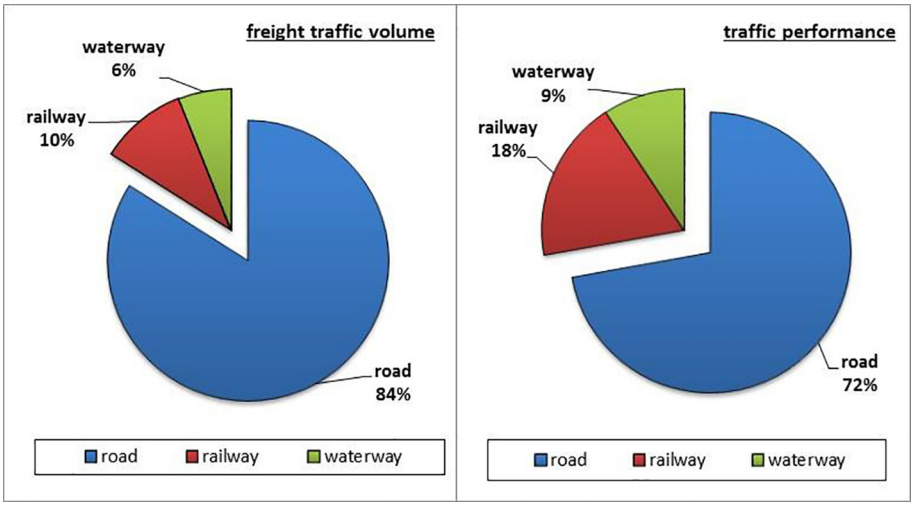

Fig. 1. Importance of transport modes – left. modal split freight traffic volume, 2010; right. modal split of traffic performance, 2010 (BMVI, 2014)).

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