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Original Research Paper

Noise emission of concrete pavement surfaces produced by diamond grinding

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ABSTRACT

In Germany, diamond grinding is frequently used to improve the evenness and skid resistance of concrete pavement surfaces. Since diamond grinding has been observed to affect tyre/pavement noise emission favourably, the relationship among surface texture, concrete composition and noise emission of concrete pavement surfaces has been systematically investigated. The simulation program SPERON was used in a parameter study to investigate the main factors which affect noise emission. Based on the results of the simulations, textured concrete surfaces were produced by using a laboratory grinding machine. As well as the composition of the concrete, the thickness and spacing of the diamond blades were varied. The ability of the textured surfaces to reduce noise emission was assessed from the texture characteristics and air flow resistance of textured surfaces measured in the laboratory. It was found that concrete composition and, in particular, the spacing of the blades affected the reduction in noise emission considerably. The noise emission behaviour of numerous road sections was also considered in field investigations. The pavement surfaces had been textured by diamond grinding during the last years or decades. The results show that diamond grinding is able to provide good, durable noise-reducing properties. Several new pavement sections were investigated using thicknesses and spacings of the blades similar to those used in the laboratory to optimize noise emission reduction. It is concluded that diamond grinding is a good alternative to exposed aggregate concrete for the production of low-noise pavement surfaces.

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1. Introduction

The surface texture of road pavement significantly affects the emission of tyre/pavement noise. It affects both the vibrations

of tyres and the aero-dynamic processes occurring between the tyres and the pavement surface that lead to noise emission. In Germany, diamond grinding has been used successfully for many years to improve skid resistance and the evenness of concrete pavement. It was observed that grinding

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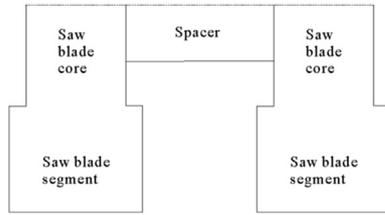


Fig. 1 – Typical configuration for grinding.

also has a favourable effect on noise emission. However, up to now it is not known which textures produced by grinding are particularly suitable for noise reduction. The effect of various parameters on the textural properties of concrete pavement surfaces produced by grinding and the resulting noise levels have been studied in a research project (Villaret et al., 2013). The research project was performed in cooperation between the engineering company Villaret Ingenieurgesellschaft, the TU München and Müller-BBM. The most important results of the project are presented here.

2. Grinding and grooving

Diamond ground texture is produced by running a series of saw blades which are gang-mounted on a drive shaft over the concrete surface. The depth of grinding is between 3 and 5 mm. Diamond-tipped grinding segments, variable in width, are situated at the edge of the blades. The separation of the blades is set by spacer disks and is at most 3 mm, which is shown in Fig. 1.

Diamond ground texture consists of grooves and land areas, i.e. the regions between consecutive grooves. The width of the grooves is determined by the width of the segments and the width of the land areas by the separation of the segments determined by the spacer thickness. Fig. 2 shows a cutting head and a typical surface texture.

Grooving is also produced by using running diamond grinding blades on a rotating drive shaft over the pavement surface. In contrast to grinding, the blades are separated by more than 10 mm. This method is primarily used to improve the water drainage of pavement surfaces. Fig. 3 shows a diamond grooved texture.

In USA, diamond grinding and grooving are used for other purposes besides the improvement of pavement evenness and skid resistance. Specially designed cutting heads are used



Fig. 2 – Cutting head and typical surface texture. (a) Grinding head. (b) Typical diamond ground texture.



Fig. 3 – Diamond grooved texture (source: Otto Alte-Teigeler GmbH).

to texture the surface of city roads. These surfaces are particularly suitable for recreational activities such as bike riding or roller skating. Fig. 4 compares a diamond ground texture for city roads with a conventional texture.

Moreover in the United States, a special type of surface is used to reduce noise emission, the so-called Next Generation Concrete Surface (NGCS) which currently provides the best noise reduction for concrete pavement (Scofield et al., 2010). The production of NGCS consists of a combination of diamond grinding with minimum separation of the segments and conventional grooving. Fig. 5 shows the cutting head and the produced NGCS.

The NGCS can be applied to both newly constructed and existing pavement. Up to now, neither NGCS nor diamond ground texture for city roads has been used in Germany. Diamond grinding is mainly used to improve the skid resistance and evenness of concrete pavement for autobahns.

3. Diamond grinding in Germany

In Germany, diamond grinding has been used successfully for many years to improve skid resistance and the evenness of concrete pavement (Fig. 6). In this case, blade segments 3.2 mm in width with a spacing of 2.2 mm are mainly used. In the past, cutting heads with 80 cm–100 cm in width were used for producing diamond ground texture. Modern cutting heads currently possess a working width of 140 cm. The

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