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Analysis of Road Cover Roughness on "Control" Road Section with Crumb Tire Rubber

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Abstract

Results of acoustic level measurements are presented in the paper. Measurements were carried out on "control" road sections in Mala Ida village (Kosice region, Slovakia) and Haniska village (Presov region, Slovakia). Descriptions of the sections, conditions of laying and technology of the mixture are given in the paper too. During the period between autumn 2014 and spring 2015 noise levels and pavement surface characteristics were investigated on experimental road sections consisting of asphalt concrete pavement with addition of crumb rubber from waste tires. The surface properties of the in-service pavement were measured to establish the characteristics of a "control" road constructed with crumb tire rubber. Correlation of the results from the measured surface characteristics in pavement with crumb tire rubber indicates that the parameters of roughness and texture could have a relevant role in global tire/pavement sound emissions.

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Keywords: Noise; tire; crumb rubber; roughness; road cover

1. Introduction

Asphalt mixtures with crushed rubber have been tested for over 50 years all over the world and there is a demand for asphalt mixtures with better deformation resistance properties for parts of roads which are more loaded by traffic. The price of asphalt mixture with crumb rubber is the same as traditional asphalt pavements, and adding crushed rubber also helps to re-use recycled waste materials. Using this waste in asphalt mixtures could help resolve this problem and improve asphalt mixture properties for the surface course. Asphalt mixtures can be modified with crushed rubber in different ways. Crumb rubber can be incorporated into the mixtures using dry and wet processes. In the dry process, crumb rubber replaces some of the solid fraction in the mixture as part of the aggregates [1].

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On the other hand, in the wet process it is added to bitumen before mixing it with the aggregates. For this reason our experimental road section was made with addition to the mixture of crumb rubber from used tyres using the dry method, where crushed rubber is added to the mixture as an aggregate replacer, since this method can be used with traditional manufacturing equipment without any investments or alterations and renewals.

Low-noise road surfaces are seen as a good option for abating traffic noise. These surfaces include porous asphalt, which can absorb sound energy [2]. Experiments of [3] show good fatigue resistance and track copying resistance on a road section with crumb rubber. Vasiljev at al. [4] showed the interaction between road traffic noise and friction coefficient and increase in noise levels with increasing road friction coefficient. Bernhard at al. [5] studied the influence of pavement surface type on tire/pavement generated noise. The main focus of the research was to: 1) evaluate how different pavement surfaces influence the generation of tire/pavement noise; 2) evaluate the effect of vehicle speed on the tire/pavement generated noise; 3) provide guidance as to the repeatability of the CPX (Close Proximity) method and optimal test distance on the roadway to aid in maximizing testing efficiency. Results of the testing indicated that asphalt-based surfaces provided the lowest tire/pavement noise levels. Vázquez, Paje [1] studied the surface properties of some in-service pavement, which are most important in controlling the acoustic performance (texture, acoustic absorption and dynamic stiffness or mechanical impedance). These were measured to find out the characteristics of a test track constructed with and without crumb tire rubber. Correlation of results from testing these surface characteristics in a pavement with crumb tire rubber added using the wet process suggests that the parameters of roughness and texture could play a relevant role in global tire/pavement sound emissions; whereas dynamic stiffness influence is relatively minor. Bueno at al. [6] showed that analysis of the measurements indicated that the incorporation of crumb rubber as well as the air-void content had less influence than the macrotexture of the road surface on the acoustical behavior of their experimental asphalt pavement. Many tire/pavement sound studies have focused on the road texture; however, for a complete road surface characterization with respect to noise emission, the sound absorption and the dynamic stiffness (or mechanical impedance) of the surface should also be measured [7]-[10]. Description of the technology and composition of our “control” road section for better understanding of the issues is presented in the next section of this paper.

2. Experimental measurements

2.1. Description of technology and composition of “control” road section

Considering the large amount of material recycled from tires, this material has become the subject of worldwide research focused on its utilization potential. In search of the potential uses of recycled tires in construction, attention is focused primarily on their use in asphalt mixtures, which are applied to different structural layers of road pavement. The experimental road section at Mala Ida (Slovakia, Kosice region) consists of asphalt concrete with added crumb rubber. The studied asphalt mixture was developed within the project "NFP 26220220051 Development of progressive technologies for utilization of selected waste materials in road construction engineering, supported by the European Union structural funds" at the Department of Geotechnics and Traffic Engineering, Technical University of Kosice. After the asphalt mixture went through laboratory testing, an experimental road section was constructed. The original surface layer of this road was replaced with asphalt mixture with addition of crumb rubber. Crumb rubber is an elastic material and its behaviour could improve classic asphalt mixtures in loaded roadways. Asphalt mixtures can be modified with crushed rubber in different ways. Properties of asphalt mixtures with added rubber have been monitored using wet as well as dry methods. The wet method is based on mixing crushed rubber and asphalt binder at elevated temperature, and the final product is asphalt rubber binder. The dry method involves replacement of part of the aggregate with crumb rubber. The wet method for asphalt rubber pavement composition was used in preparation for this study. The rubber content should be chosen with regard to the aggregate and binder content [12]. Crumb rubber from waste tires was supplied by the company V.O.D.S. a.s., and this product fulfils all current environmental and health standards in the EU. The tire rubber included natural and synthetic rubbers, with fill materials such as carbon black, sulphur, polymers, oils, paraffin, pigments, steel and polymeric fibres. Rubber granulate has a number of specific physico-chemical and thermo-mechanical properties, such as low density and durability. It is a non-toxic and inert material. Mixture AC 11 (asphalt – concrete) was chosen for the road surface course. It is one of the most often used asphalt mixtures for