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Analysis of coast-by noise of heavy truck tires

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ABSTRACT

Heavy truck tires are one of the main sources of road traffic noise. However, the mechanism and propagation of the noise generated by these tires have not been systematically investigated. To determine the noise of heavy truck tires with different structures and patterns, and to analyze the correlation between the indoor tire noise and coast-by tire noise, an integrated tire indoor noise test and a coast-by noise test were designed and successfully implemented. The indoor test was conducted on a drum inside a semi-anechoic chamber to simultaneously measure the near field and far field noise of the tires. The outdoor measurements were carried out using a coast-by test on the new ISO 10844 surface. A formula for quantitative analysis with appropriate corrections was developed to analyze the data with reasonable errors, which can be used to predict the coast-by noise through the indoor tire noise test accurately and effectively. The analysis shows that when trying to build the relationship between indoor and outdoor heavy truck tire noise, care should be taken to differentiate the tires with a load capacity index in excess of 121 and without any dual fitting indication from ordinary tires, due to the specified test procedure.

1. Introduction

It has been well recognized that when the speed of a passenger car or a truck exceeds 60 km/h, the tire noise becomes the dominant source of vehicle noise (Anfosso-Ledee et al., 2000; Heckl, 1986; Herman et al., 2000; Kim et al., 2007; Kropp et al., 2012; Iwao and Yamazaki, 1996; Nilsson et al., 1980; Sandberg and Descornet, 1980). The recent government regulation and code, such as the EU tire labeling law, further brings attention to tire noise behavior and mechanism on specified surface, i.e., ISO 10844 ground (Donavan, 1997, 2005; Donavan and Rymer, 2003; European Union, 2009; ISO, 2011; Landsberger et al., 2001; Sohaney et al., 2012; Moore, 2011; Sandberg, 2012). In order to understand the tire noise generation and propagation mechanism, it should measure both indoor noise in semi-anechoic chamber and coast-by noise in appropriate ways specified by UNECE Regulation 117 (UNECE, 2011) and determine their relationships. Understanding such relationships is very important for tire designers in order to

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screen and improve their products effectively and efficiently (Ge et al., 2002; Lippmann and Reid, 1976; Paje et al., 2007; Woodward et al., 2005). Unfortunately, limited data and analysis can be found in published literature on the quantitative analysis of the relationship between indoor and outdoor tire noise obtained on the road surface specified in ISO 10844 (ISO, 2011), specifically for heavy truck tires (Sandberg, 2005; Sandberg and Ejsmont, 2002).

In this study, an integrated tire indoor noise test and an outdoor coast-by noise test on the new ISO 10844 surface were designed and successfully implemented. The quantitative relationship between indoor near field noise and coast-by noise of heavy truck tires was established for the first time, based on the results obtained in those experiments and point acoustic source tire noise model. In particular, it was found that the proposed quantitative relationship between indoor and coast-by tire noise needed to be modified for wide based tires, and the physics for this modification was given by examining the test procedure of ENECE Regulation 117.

Following the introduction, in the first section, the hybrid indoor test and outdoor coast-by test are designed, including the details of the experimental process. Then the test results and relevant discussions are introduced. Conclusions come in the end.

2. Experimental design

2.1. *The indoor noise test*

The test objects were 4 sets of tires from a domestic supply. The specification of two of the sets of tires was 315/60 R22.5. One set had a block tread pattern (CM335) and the other had a rib pattern (CR966). The other two sets of tires were 385/65 R22.5. One of the sets had a mixed tread pattern (AT557) and the other set had a rib pattern (WSR1). For the sake of convenience, the tires were numbered successively as shown in Fig. 1. To understand the relationship between the indoor near

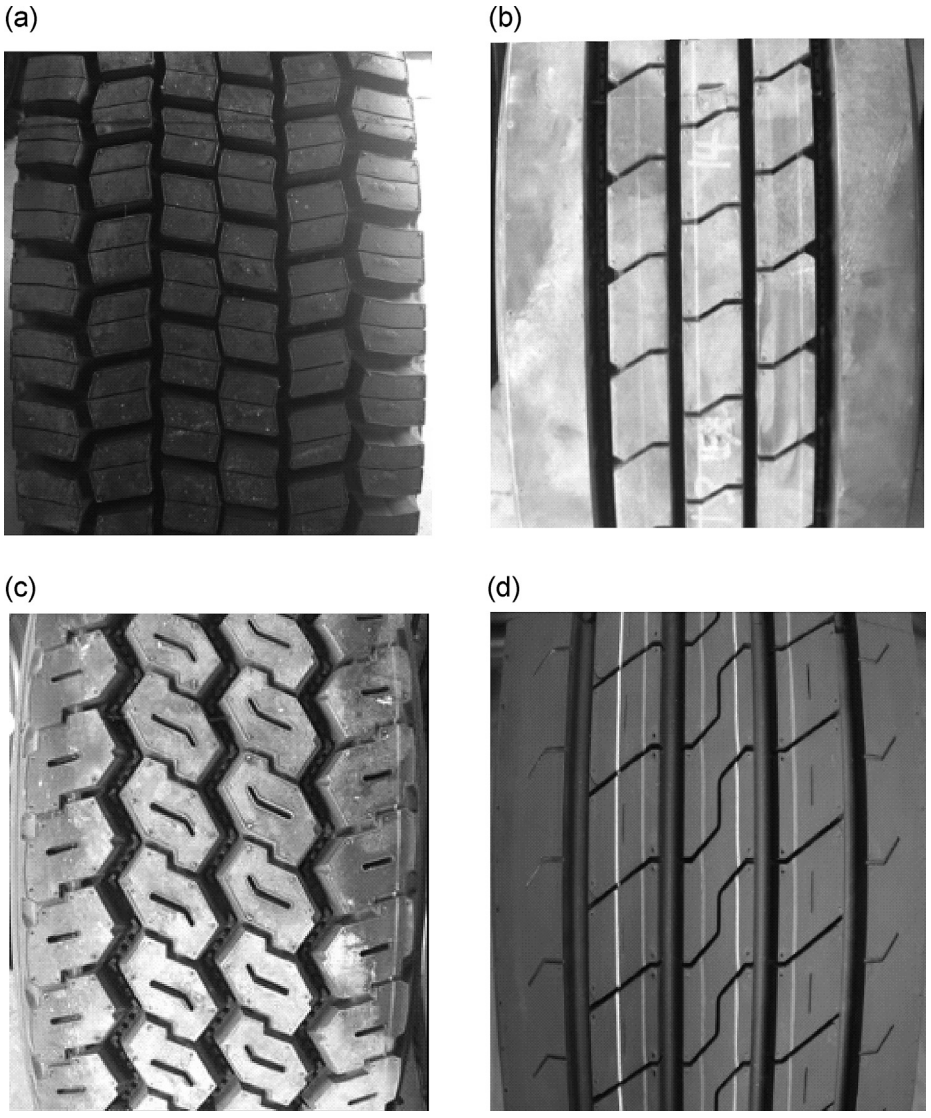

Fig. 1 – Tread pattern of test tires. (a) CM335. (b) CR966. (c) AT557. (d) WSR1.