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Investigation of laboratory and Field methods of measuring energy caused by traffic noise pollution

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ABSTRACT: The traffic noise pollution measurement has always been considered by urban transportation system managers. Sound and noise definitions, evaluation of their differences, production and propagation factors of traffic noise pollution, various laboratory and field sound energy measurement methods, noise maps, and investigation of the methods of sound energy reduction are the most important topics studied in this research. Tire-pavement interaction noise (TPIN) is known as the most important source of traffic noise pollution at speeds above 40 km/h for passenger cars and 70 km/h for trucks. Using the appropriate air void content in asphalt surfaces has reduced the noise pollution caused by TPIN up to 10 dB. Porous asphalt with more than 20% air void content has shown good performance in reducing traffic noise pollution. The severity of traffic noise pollution has been measured using laboratory and field methods. Laboratory methods can be performed in a laboratory environment and under controlled conditions. Laboratory test results are more accurate and this method has been widely used in TPIN measurements. Field methods measure the tire-pavement interaction noise (TPIN) more realistically despite ambient noise pollution.

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1- Introduction

Traffic noise pollution is one of the most important problems which is spreading in many countries. Road users are always exposed to risks including physical and mental diseases caused by noise pollution[1-2]. The interaction of the tire with the pavement surface (because of friction between tire and road surface), has been known as one of the most important factors of traffic noise pollution [3]. Vehicle speed influences on amount of traffic noise pollution propagation. Tire-pavement interaction noise (TPIN) is more critical in cars with speeds higher than 40 km/h and in trucks with speeds higher than 70 km/h [4].

The intensity of traffic noise pollution can be measured with laboratory and field methods. These methods include impedance tube [5], tire drop [6], and laboratory drum as laboratory methods and statistical pass-by (SPB) method [7-8], proximity (CPX) [8-10], and On-Board Sound Intensity (OBSI) as field methods. Laboratory methods can be performed in the laboratory environment and with controlled conditions. The results of experiments are more precise and have been widely used in measuring tire-pavement interaction noise [11]. Field methods also provide more detail. According to these points, the appropriate method should be chosen with regard to the needs of the project [12].

2- Sound and noise

Sound is a vibration that has been generated as a sound wave resulting from pressure small and quick changes in a fluid environment [13]. Sound is energy generated from the movement of material particles [14]. Generally, the performance of sound propagation is influenced by a) relation between the density and pressure of propagation environment, b) the propagation environment movement that according to movement direction can cause an increase or decrease of sound wave speed, c) the viscosity of the propagation environment [15].

In engineering science, noise is called an unwanted signal that has had undesirable impact on other signals and caused noise pollution and acoustic disturbance. Also, noise can be named unwanted sound. Noise as unwanted sound is a type of vibration that has propagated through the fluid environment like water or air [13,16]. For example, sound propagated from tire-pavement interaction has been called noise because of undesirability. Humans can receive and understand sound levels between 20 Hertz to 20,000 Hertz and the maximum sensitivity region of human hearing is between 1000 to 4000 Hertz. The human hearing range is shown in Figure 1.

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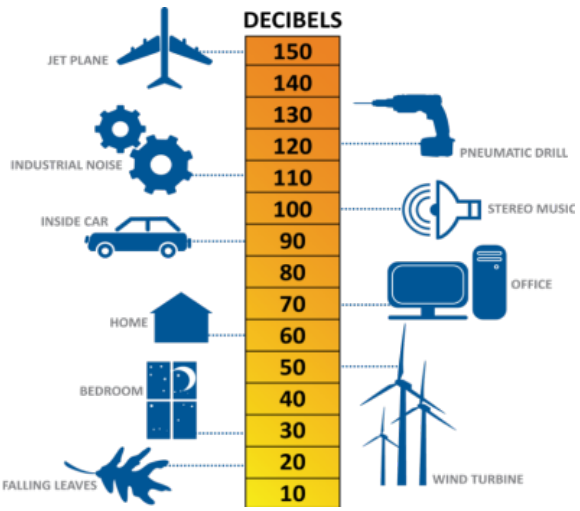

Fig. 1. Human hearing range according to various sounds intensity in Decibel.

3- Laboratory and field methods for measuring traffic noise levels

To determine the methods of reducing traffic noise pollution, it is important to know the reliable methods of measuring noise levels [13]. In this section, methods for measuring tire-pavement interaction (TPIN) can be divided into two laboratory and field methods.

3- 1- Laboratory measurement methods

Various laboratory methods have been developed to evaluate and assess acoustics features of pavements. In laboratory methods, simulating and measuring sound is performed in laboratory environment and on samples constructed in the laboratory and with controllable conditions [11-12]. The results of these methods are precise and repeatable. However, results of different research have shown that laboratory methods cannot indicate the real performance of pavements [17]. These methods include ways for measuring the amount of sound absorption and sound levels. These laboratory methods include the laboratory drum method, impedance tube method, and tire drop method.

3- 2- Field measurement methods

Sound levels generated in the road can be measured using field methods. In these methods, sound levels can be measured using both inner moving microphones and stationary microphones, and measured noise is expressed based on A-weighted sound pressure level (SPL) and by Decibel [12]. Sound absorption amount can be also measured by using these methods. These methods include pass-by methods which can be divided into Statistical Pass-by (SPB) method Controlled Pass-By (CPB) method, Close Proximity (CPX) method, and On-Board Sound Intensity (OBSI) method.

4- Traffic noise map

Noise maps have been prepared To analyze noise pollution. Detection at the right time and management planning can be done by analyzing noise maps. Noise pollution map is a graphical demonstration of sound levels distribution and sound wave propagation in a specific local domain and for a given time interval.

5- Conclusion

Laboratory and field methods have been used for traffic noise measurement. According to research results, laboratory methods are more precise while field methods are closer to reality. Also, laboratory measurement methods can significantly reduce the impact of environmental factors. Among the advantages of controllable measurement conditions, we can mention the repeatable test environment and accurate measurement results. The most popular laboratory method in TPIN simulation is the impedance tube method. Research studies have shown that the use of field methods can effectively simulate real conditions. Although more details have been obtained in pass-by methods, they are much more time-consuming and expensive than CPX and OBSI methods. The results of this investigation show that OBSI method has provided better results than other methods. Also, the analysis of different methods using the TOPSIS model has indicated this fact.

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