Analyzing Noise Pressure Level at Different Setting Location of Microphone on Tire/Surface Noise Measurement

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ABSTRACT

The purpose of this study is to investigate the change of sound pressure levels under different settings and placement of microphones on the tires using various vehicle types when tire/surface noise is measured. Tire/surface noise is measured using four types of vehicles (passenger car, Van, bus, and truck) on both asphalt and concrete pavements with prohibited traffic flow.

The surface microphone is used to measure tire/surface noise installed near the tire while the tire/surface noise is measured at various vehicle speeds between 60 km/h and 100 km/h. For small vehicles (passenger car and Van), tire/surface noise is measured from 8 microphones that is installed on the right and left sides of the front and rear tires. For large vehicles (bus and truck) tire/surface noise is measured from 6 microphones that is installed on the right side, center and left sides at the front tire. Based on the tire/surface noise measurement at different locations of microphone using different types of vehicle, sound pressure level changed from 0.7dB/A to 11dB/A. However, in this study, tire/surface noise is influenced by the types of vehicle and the placement of microphone.

Therefore, the placement of microphones for different type of vehicles should be reviewed in order to measure accurate tire/surface noise using the NCPX method.

Keywords: Tire/road noise, NCPX, Surface microphone I-INCE Classification of Subjects Number(s): 13.2

1. INTRODUCTION

Widely-used ways to measure tire/surface noise include OBSI (On-Board Sound Intensity, AASHTO TP 76-11) generally used in the USA and CPX (Close Proximity Method, ISO/DIS 11819-2.2). With the OBSI method, noise is measured with a microphone installed on a separate stand near the tire. With the European-developed and ISO-certified CPX method, tire/surface noise is measured with a microphone installed on a separate trailer. However, both methods require installation of an additional microphone on a stand or a trailer to measure noise which may be cumbersome. Korea has developed a simpler way to measure noise, which is called NCPX (Novel Closed Proximity) without installing a microphone on a stand or a trailer, but installing a surface microphone on a tire surface as shown in figure 1 (Cho, D.S. et al., 2008; Mun, Sungho, 2007). However, microphone locations have not yet been officially regulated. Therefore, this study aims to compare sound pressures of each position by installing surface microphone near the tire.

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Figure 1 - Noise Measurement from Noise Source (NCPX Method)

2. Test Section

Figure 2 shows test section for noise measurement. In order to eliminate influence from passing-by cars when measuring noise, the traffic was restricted in the test section. The experiment was conducted on passenger car, Van, truck and bus with the running speed of 60 km/h, 80 km/h and 100 km/h.

Figure 2 - View of Test Section

3. Noise Measurement Methods and Conditions

In general, a stick-type microphone is used for measuring tire-surface noise and the microphone depicted in the table 1 is used with the NCPX Method. The surface microphone is easily installable anywhere on the vehicle.

Table 1 - Major Performances of B&K Surface Microphone (Source: www.bksv.com)

Dynamic range	30dB to 140dB	
Frequency range	5Hz to 20kHz	
Diameter	1/2inch	
Temperature Range	-30℃ to 100℃	
Type	CCLD	

The vehicle types used to measure tire/surface noise include passenger car, Van, bus and truck and the positions where microphone is installed are presented in the figure 3. Total of four microphones were installed on front and rear tires of passenger car and Van and six on bus and truck.

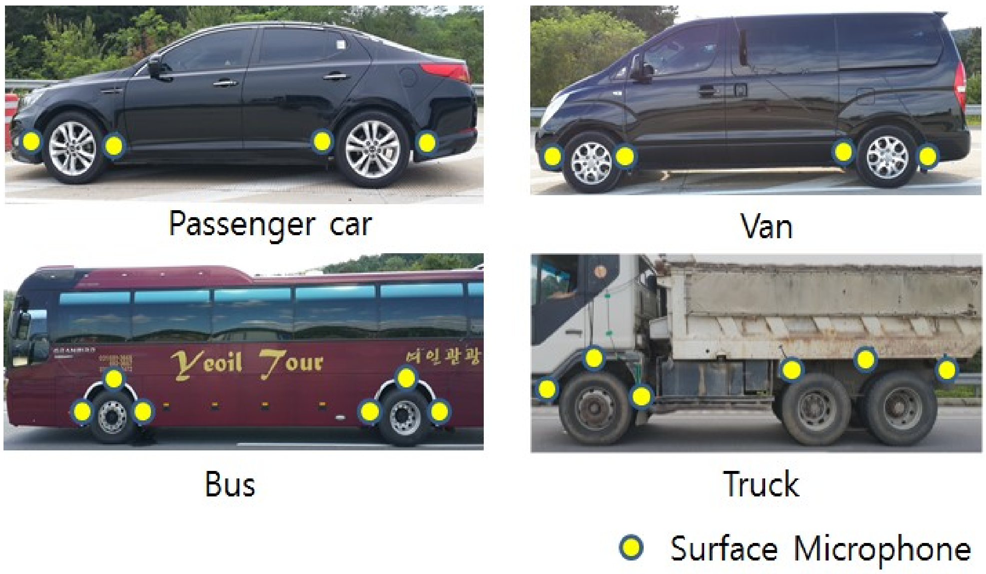

Figure 3 - Surface Microphone Position by Car Type

A total of nine tests were conducted for each vehicle presented in figure 3, three sessions per running speed of 60Km/h, 80Km/h and 100Km/h. The test sessions were repeated to verify repetitiveness of noise measurement and noise was measured by running speed to identify the noise increase depending on various speeds. In addition, engine power was maintained at the same level in order to minimize engine noise from acceleration and deceleration when measuring noise.

4. Noise Characteristics by Microphone Position

In case of asphalt pavement, equivalent sound level changes by microphone position and by vehicle type is indicated in figure 4. Passenger cars and Vans have increased noise levels on the back of the front tire and buses and trucks on the font of the front tire. Passenger cars show the biggest noise deviation by microphone position (7.7-11.0 dB(A)) and vans show the smallest deviation (3.0 – 4.0 dB(A)).

In case of concrete pavement, equivalent sound level changes by microphone position and by car type are shown in the figure 5. The maximum noise positions by microphone position and by car type were similar with the measurement resulted for asphalt pavement. Passenger cars show the biggest noise deviation by microphone position (7.7-11.0 dB(A)) and buses show the smallest deviation (6.5 – 8.0 dB(A)).

As a result, passenger cars presented the biggest noise deviation according to surface microphone position on front tire and rear tire, therefore, the location of the surface microphone should be considered. The maximum noise deviation of passenger cars was 4.0dB(A) on asphalt pavement which is relatively compared to other vehicles which indicate that it is suitable for the NCPX measurement method. In addition, small cars show the biggest equivalent noise level from the back of the front tire due to the influence of engine noise. Therefore, it is appropriate to set the back of the rear tire as the standard when measuring noise of small cars.

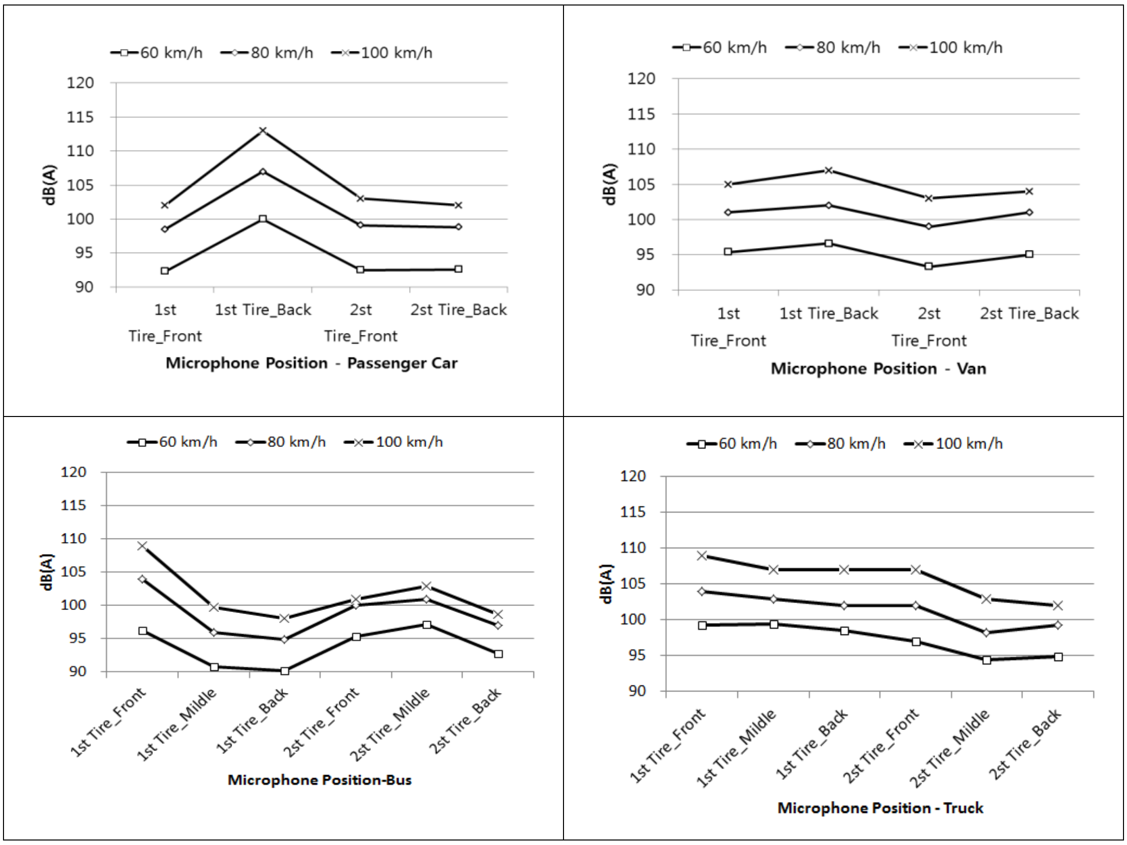

Figure 4 - Sound Pressure on Asphalt Pavement by Microphone Position

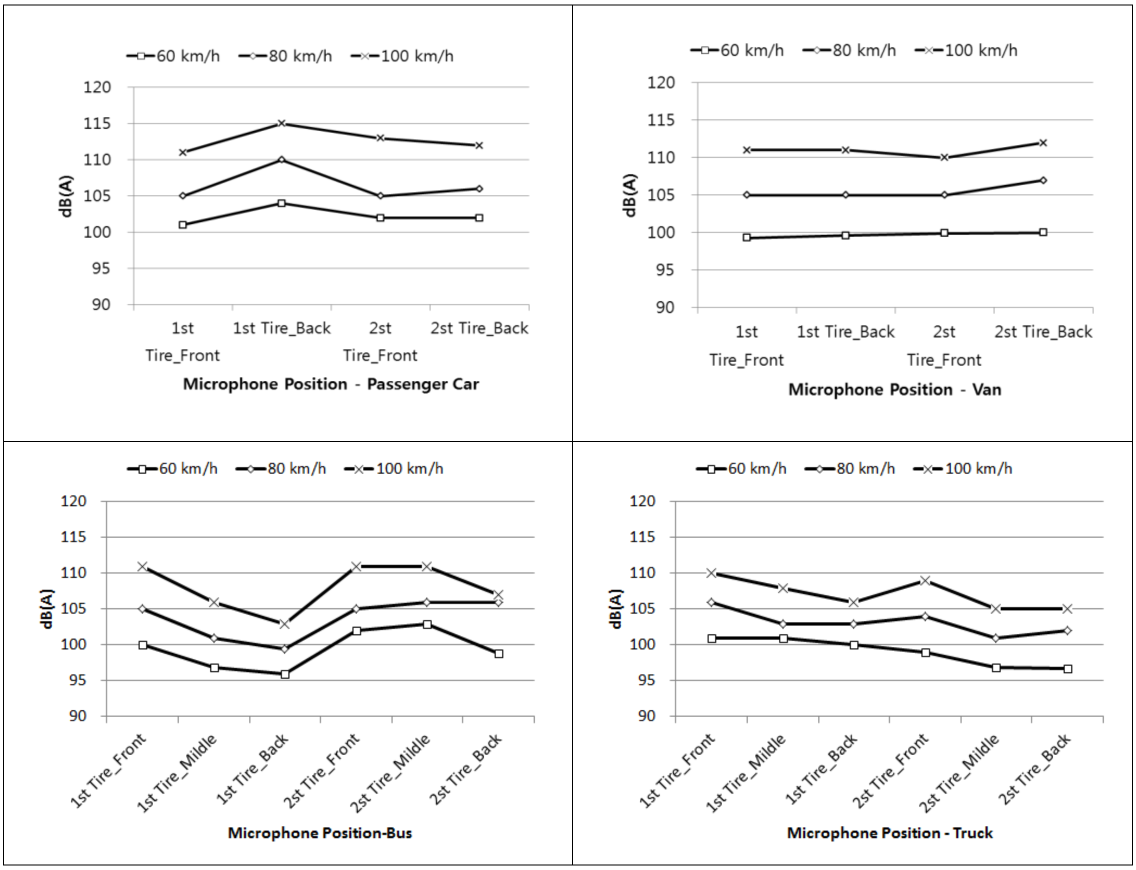

Figure 5 - Sound Pressure on Concrete Pavement by Microphone Position

5. CONCLUSIONS

This research analyzed noise measurement result of different cars by microphone position when measuring tire/surface noise using surface microphone. And the experiment results are as follows.

1. When tire surface noise was measured using surface microphone, Vans show the least sound pressure deviation by microphone position. The maximum deviation of asphalt pavement noise was 4.0dB(A) and 2.0dB(A) for concrete pavement.

2. Sound pressure was measured the largest on the back of the front tire when measuring tire-surface noise of passenger cars compared to that of larger vehicles. This phenomenon seems to be influenced by the fact that in the case of front tires, surface noise is influenced by running engine sounds. Therefore, it is recommended not to install microphones on the back of the front tire when measuring tire-surface noise of a passenger cars.

ACKNOWLEDGEMENTS

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