A Study of Traffic Noise Characteristic of Pavement Types Using NCPX Method

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ABSTRACT

To analyze the traffic noise as changed pavement types, a research team measured traffic noise in test load located in YeoJu, Korea. The test road was composed of four different pavement types as followed; Dense grade asphalt concrete pavement (ACP), Joint concrete pavement (JCP), Continuous reinforced concrete pavement (CRCP), Transverse grooving on jointed concrete pavement (GJCP). In order to measure traffic noise as function of vehicle speed at interface between pavement and vehicle tire, NCPX (Noble Close ProXimity) method was adopted in the study. Based on analysis of test results, transverse grooving on JCP was shown the highest SPL 110.5 dB(A), However, Dense grade asphalt concrete pavement was shown the lowest value, 101.5 dB(A). Therefore, the transverse grooving on JCP is average 9 dB(A) higher than that of asphalt concrete pavement. Also, the sound pressure level (SPL) was analyzed between front and rear axle in vehicle. The front SPL was average 4.4 dB(A) higher than that of rear SPL. In this case study, asphalt concrete pavement shows the highest differences in SPL with 7.4 dB(A). However, CRCP was lowest differences in SPL with 3 dB(A). It implies that there is different interaction between tire and road as changed vehicle axle.

Keywords: Noise Characteristic, NCPX(Noble Close Proximity), SPL(Sound Pressure Level), Tire/Road Noise   I-INCE Classification of Subjects Number(s): 13.2

1. INTRODUCTION

Recent, because of traffic noise from the highway, resident near highway was struggled with anxiety, sleep disturbance and mental damage.

In general, traffic noise of the tire/road noise, mechanical noise, and aerodynamic noise by acting in combination caused complaints and disputes in residential area near highway.

To measure and analysis traffic noise, CPX (Close Proximately Methods) is commonly used in the world. Also, CPX method was currently adopted to study interaction noise at interface tire and pavement.

Ulf Sandberg etc. (1998) studied traffic noise characteristics related Portland cement concrete texture and evaluated age vs. pavement condition using CPX. Also, Michael T etc. (2000) researched between tire/pavement and interaction noise using both Pass-by and CPX methods.

Ahn, etc. (2012) has studied two types transverse rumble’s noise. They used CPX method to measure interaction noise between tire and pavement. Kim, etc (2010) has researched traffic noise characteristic of fine-size exposed aggregate Portland cement concrete pavement that was

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constructed in Daejeon-Dangjin express highway in Korea. Kim used the CPX method and analysis traffic noise characteristic.

In general, two methods, Pass-by method and Closed Proximately method, commonly used to measure a traffic noise. In this study,

The object of this study was comparison various sound pressure of traffic noise as changed pavement types which were composed of dense grade asphalt concrete pavement (ACP), jointed cement concrete pavement (JCP), transverse grooving on jointed cement concrete pavement (GJCP), and continuous reinforced concrete pavement (CRCP). The CPX method was adopted to measure an interaction noise at tire/pavement of various pavements.

2. NOISE MEASUREMENT

2.1 Test Section

The test was conducted at test road of Korea Expressway that is located at YeoJu, Gyeonggi-Do, Korea. The test road as seen in Figure 1 was composed of various pavement types. The research teams choose four different pavement types: Dense grade asphalt concrete, Jointed concrete pavement, Transverse grooving on jointed concrete pavement, and Continuous reinforced concrete pavement.

Figure 1 – Test Section

2.2 Measuring Methods and Equipment

External noise generated between tire and pavement was measured by Noble Close Proximity (NCPX) in this study. Figure 2 describes microphone position on testing vehicle. As seen in Figure 2, two microphones were mounted on front tire at both front and rear fender panel. Testing was conducted with a sedan and three different speeds such as 60km/h, 80km/h and 100km/h.

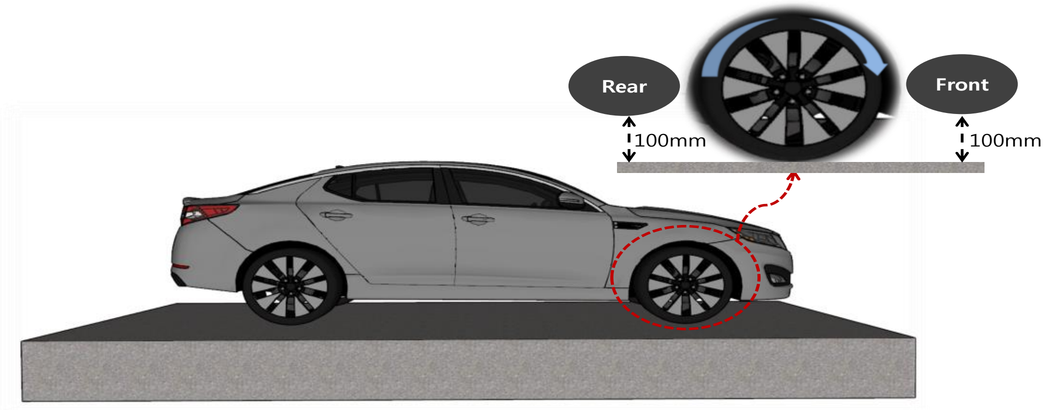

Figure 2 – Microphone Positions

To measure and analysis of the traffic noise, Microphone, Pulse analyzer, and laptop were used. In this study, surface microphone type 40PS of G.R.A.S company was used and Table 1 explains detailed the microphone information. Further, as shown in Figure 3, noise data acquisition and analysis was conducted using Pulse analyzer and Pulse 16 software program of B & K Inc.

Table 1 – Microphone Information

Properties	Performance
Frequency range	20 Hz – 20 kHz
Diameter	13.2 mm
Height	2.8 mm
Weight	3 g

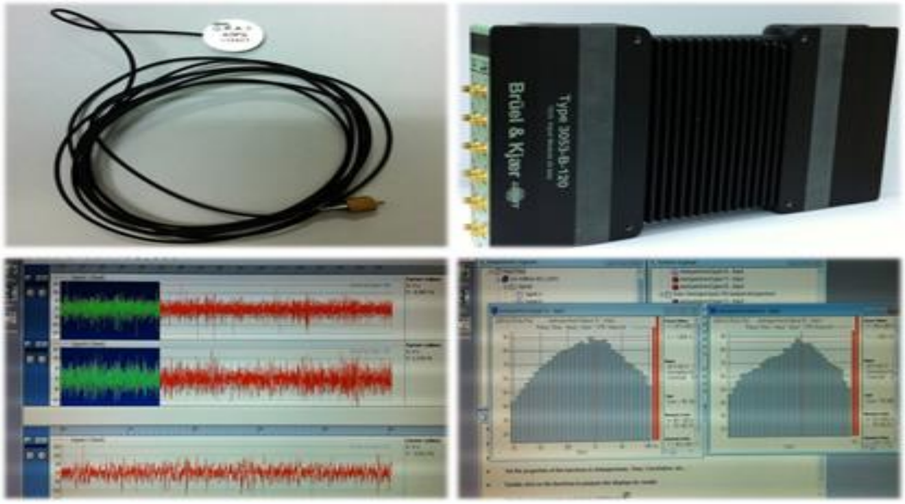

Figure 3 – Noise Measurement Equipment

3. DATA ANALYSIS

Typically, a frequency analysis of the traffic noise was performed with FFT (Frequency Fourier Transform), and CPB (Constant Percentage Bandwidth).

In this study, CPB analysis method was adopted. CPB is defined relative to their position in the frequency range of interest. The bandwidth is defined in octaves, or as a fixed percentage of the center frequency of the filter. A typical CPB analysis uses 1/3-octave band. The 1/3-octave band was used to analysis various traffic noise as function of pavement types and frequency bands.

3.1 Sound Pressure level of Various Pavement Types

Figure 4 shows the ACP tire-pavement noise analysis. As seen in Figure 4, there is 7.4 dB(A) different sound pressure between front and rear fender panel. As increased speed, the sound pressure was increased.

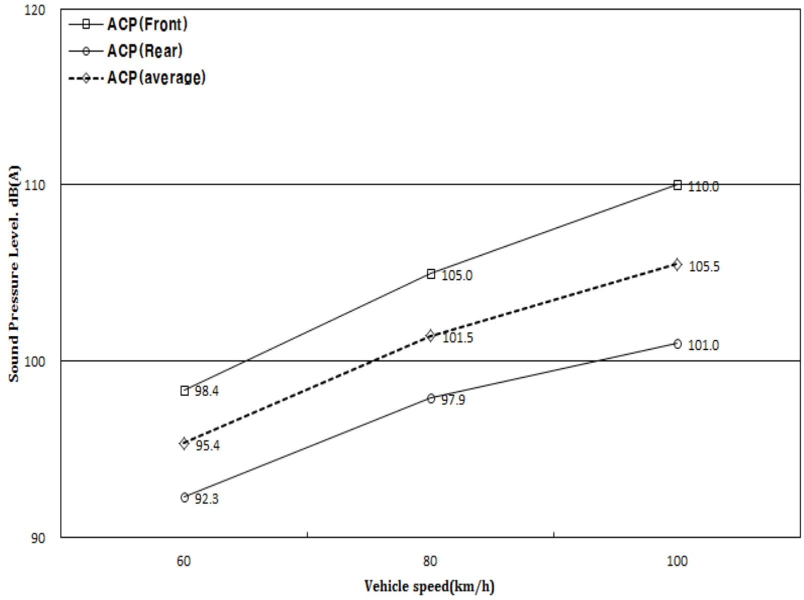

Figure 4 - Sound Pressure Levels of Dense Grade Asphalt Concrete Pavements

Figure 5 describes tire-road noise analysis of JCP. As seen in Figure 4, the same trend was found. The front fender panel showed the higher sound pressure. As vehicle speed of 20km/h by increasing, the sound pressure was increased by 5.1 dB(A).

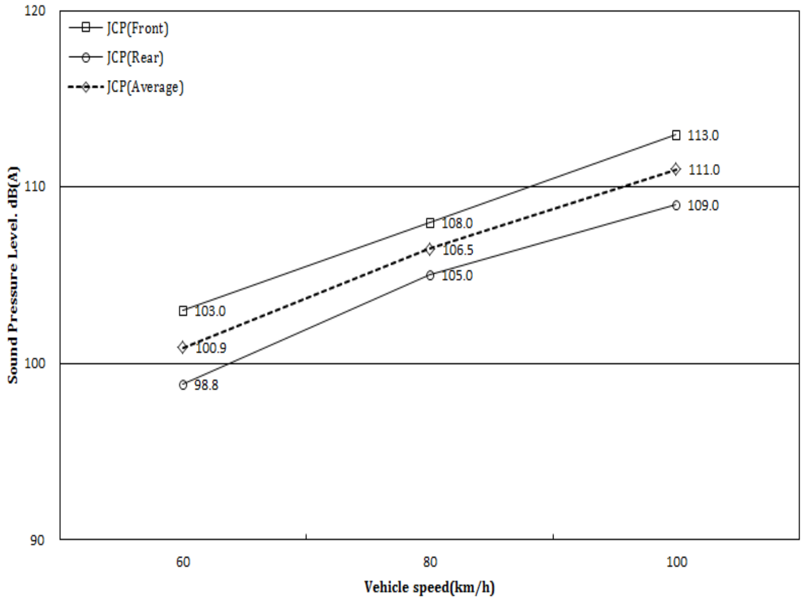

Figure 5 - Sound Pressure Levels of Jointed Concrete Pavements

Noise at tire and pavement of transverse grooving on JCP was explained in Figure 6. As seen in previous Figures, the front fender panel showed the higher sound pressure. The noise at front fender was measured average 112 dB(A). As vehicle speed of 20km/h by increasing, the sound pressure was increased by 4.8 dB(A).

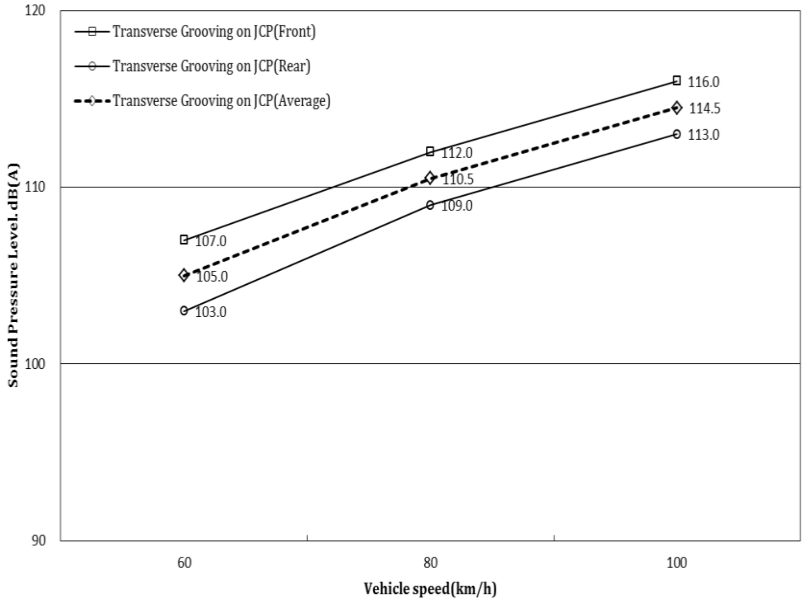

Figure 6 - Sound Pressure Levels of Transverse Grooving on Jointed Concrete Pavements

In case of CRCP, Figure 7 explained the measured noise trend between front and rear fender. As explained in Figure 7, the traffic noise was increased as increased vehicle speed. In addition, the front fender was shown 3.0 dB(A) the higher noise value.

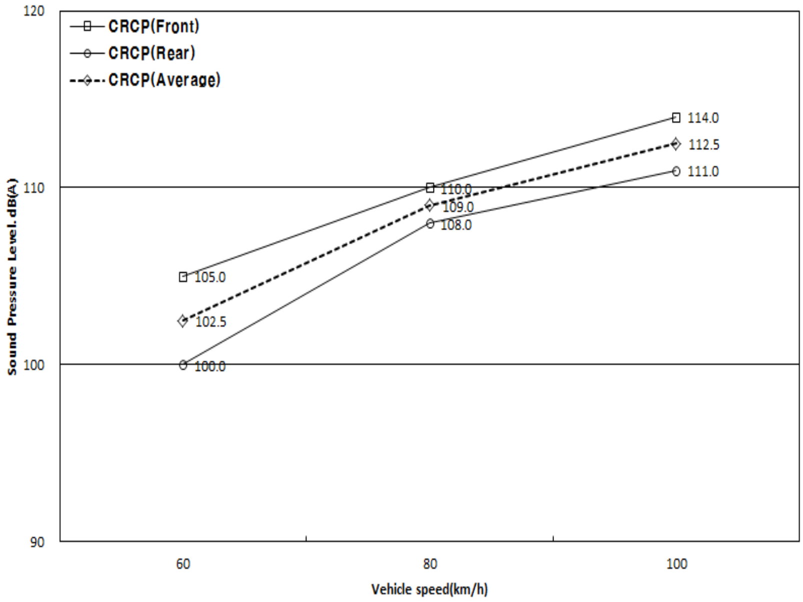

Figure 7 - Sound Pressure Levels of Continuous Reinforced Concrete Pavements

3.2 Frequency Band of Various Pavement Types

The general traffic noise on the basis of the center frequency band is 1 kHz, the main frequency bands were derived as follows.

Overall, there was no difference between sound pressure and pavement type in more than 1 kHz frequency band. However, in the low frequency, below 1kHz, transverse grooving on jointed concrete pavement was shown a 102.9 dB(A). It was the highest values in various factors. A main frequency band was shown between 100 Hz and 630 Hz. But, the traffic noise of ACP was measured a 92.3 dB(A) that was lowest value. And the range of frequency band was from 50 Hz to 2 kHz.

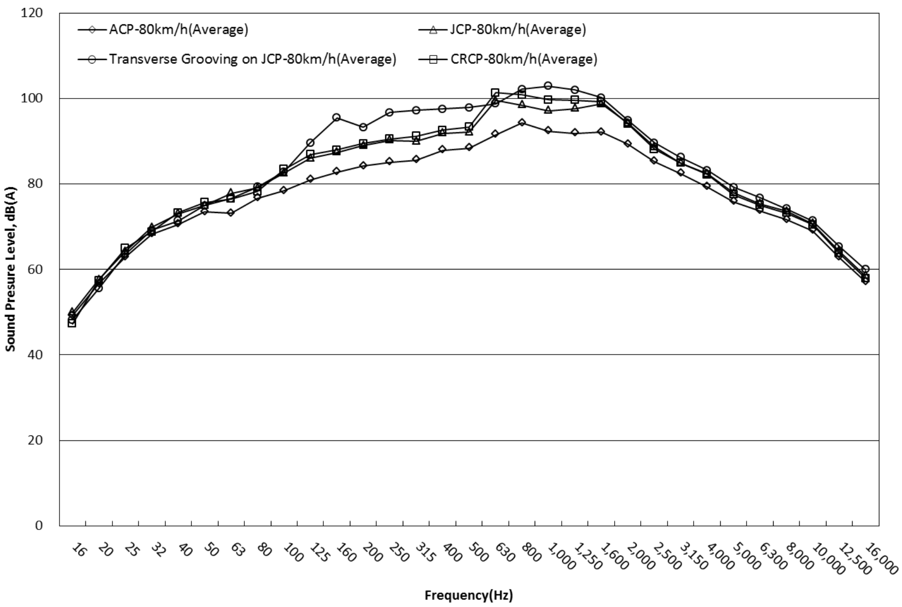

Figure 8 – Frequency band of Pavements Types

4. CONCLUSIONS

Conclusion in this study was summarized as follows.

1. The noise value of transverse grooving on jointed concrete pavement was average 110.5 dB(A), and Dense grade asphalt concrete pavement was average 101.5 dB(A) in the lowest noise value.

2. In comparison of pavement noise between front fender and rear fender, the traffic noise of front fender was larger than that of rear fender although pavement types were changed.

3. As increased vehicle speed, the traffic noise was increased from all pavement types.

4. Frequency band below 1 kHz was changed as function of pavement types. However, there was no different sound pressure over 1 kHz frequency band.

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