Analysis of Noise Level by Chang of Vehicle Speeds at Different Types of Vehicle

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ABSTRACT

A noise level differs from change of vehicle speeds at the real road condition. Typically, a noise level increases as the vehicle speed increases. In this study, the change of noise level was investigated at different vehicle speeds using four different types of vehicle. The noise was measured as increasing vehicle speed of 10km/h using both pass-by method and NCPX methods. This noise measurement results were compared with the simulation results obtained from Cadna-A program. Based on the analysing results, for pass-by method, 1.5dB(A) increases as 10km/h of the vehicle speed increases. While, for NCPX method, 2.3dB(A) increases as 10km/h of the vehicle speed increases. NCPX method shows that the noise level is significantly increased by the speed of passenger car and van. However, pass-by method shows that the noise level is significantly increased by the speed of bus and dump truck. Therefore, it could be used to manage the vehicle speed at downtown and living area in order to reduce the traffic noise on the road.

Keywords: Pass-by, CPX   I-INCE Classification of Subjects Number(s): 13.2

1. INTRODUCTION

In many cases, residents living along the roadside complain about traffic noise. In addition, as people becomes more sensitive with noise and prefers convenient and pleasant road conditions, traffic noise has a growing importance for road managers. The major culprit of traffic noise is the friction between tire and pavement surface generated when a car drives on a road. Noise level could vary according to vehicle type, driving speed and road pavement type. Among others, vehicle speed is considered to be the biggest influence. Existing studies have proved that vehicle speed is one of the major influences on tire/pavement noise level when predicting level of noise source(1). In addition, a software (Cadna-A) that predicts noise by vehicle speed concluded that noise level increases as vehicle speed increases(2). The major noise sources of a driving car includes tire, discharge, intake, transmission, engine, etc. It has been reported that the biggest contribution is made by tire/pavement noise, which is followed by discharge and intake(3, 4). Tire/pavement noise is largely influenced by air plosive generated when tire furrow of a running car rubs against pavement, which is considered to have a close relations with vehicle speed. The research aims to review changes in noise level according to vehicle speed.

2. FIELD EXPERIMENT & DATA ANALYSIS

2.1 Field Experiment

The field experiment was conducted on four different types of cars (passenger car, van, bus and truck on a highway. The field test was conducted by vehicle speed and pavement type. The test was repeated three times at the speeds of 60km/h, 80km/h and 100km/h and the pavement type was categorized into asphalt pavement, concrete pavement (joint concrete pavement and continuous reinforced concrete pavement) and concrete pavement grooving (longitudinal grooving and transverse grooving). As a research methodology, NCPX which measures noise from its source and the pass-by

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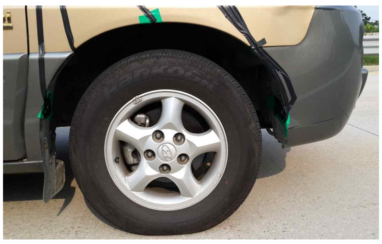
method that measures noise from pass-by point. The receiver points were set as 5m, 7.5m and 15 m from the center of the test car and the heights were set as 1.2m, 3.0m and 5.0m above road surface. Table 1 shows the summary of the field experiment.

Table 1 – Summary of Field Test Variables

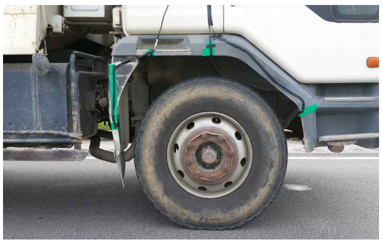
Noise Measurement Method	Pavement Types	Vehicle Types	Noise Measurement Position (Distance/Height)
Pass-by Method (Speed 60, 80, 100km/h)	Asphalt pavement, Concrete pavement (JCP, CRCP, etc.)	Passenger car, Van, Bus, Truck	5m/1.2m Point 7.5m/1.2m Point 15m/1.2m Point 15m/3.0m Point 15m/5.0m Point
NCPX Method (Speed 60, 80, 100km/h)	Asphalt pavement, Concrete pavement	Passenger car, Van, Bus, Truck	Microphone installed near tire (Front/middle/rear side of tire)

Figure 1 is the picture of surface microphone installed on test cars in the NCPX field test and figure 2 shows the experiment field for pass-by measurement.

(a) Passenger car



(b) Van



(c) Truck

(d) Bus

Figure 1 – Sensors installed in NCPX Method

Figure 2 – Pass-by Field Test (Truck)

2.2 Data Analysis

Digital signal was analysed as shown in Figure 3 and CPB frequency was analysed as indicated in Figure 4 for the data analysis collected through field test.

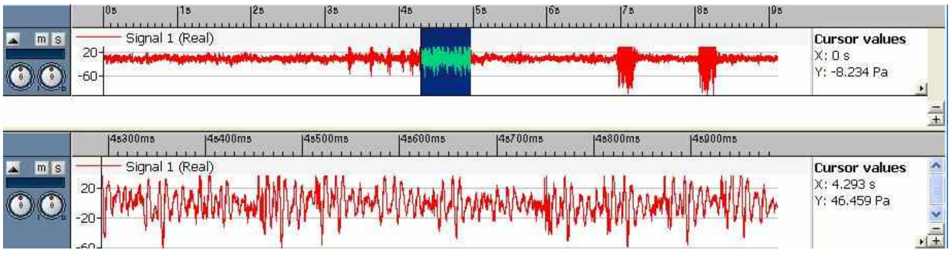


Figure 3 – Digital Signal Analysis

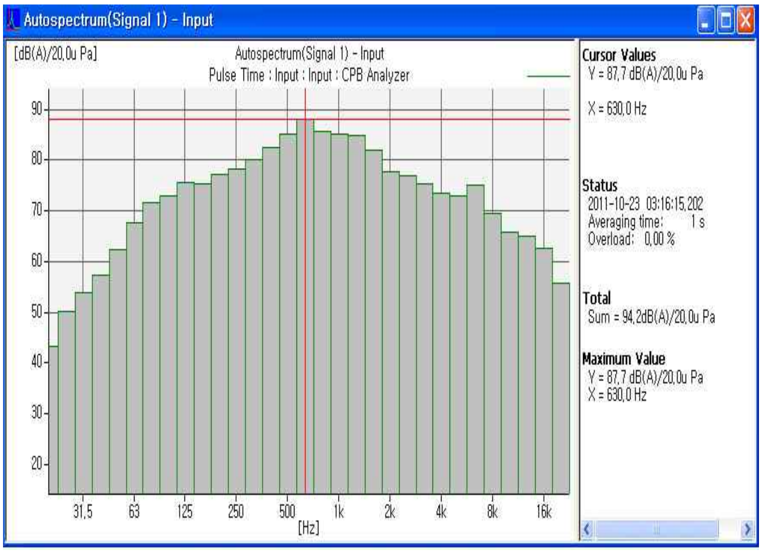


Figure 4 – Frequency Analysis

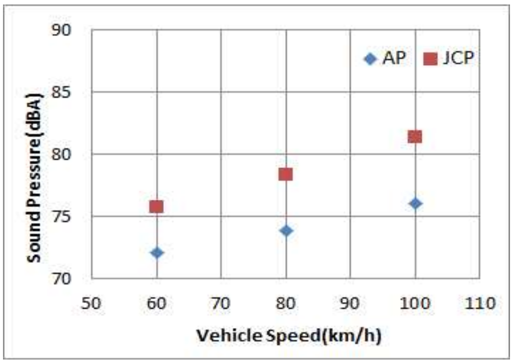
Approximately, 600 pass-by and NCPX data on passenger car, van, bus and truck were used to analyze the relations between vehicle speed and noise. In addition, a comparative analysis was conducted on vehicle speed changes using Cadna-A simulation program(2).

3. ANALYSIS RESULT

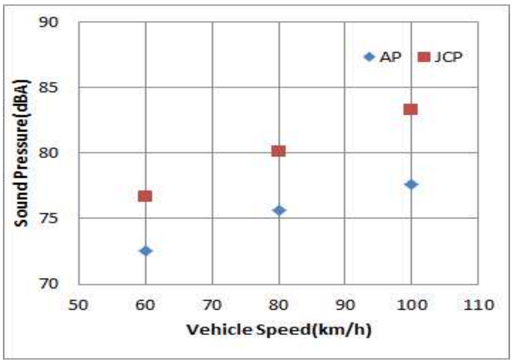
The analysis result of the field test explains tire/pavement proximity noise and pass-by noise by car type, pavement type and vehicle speed.

3.1 Pass-by Analysis

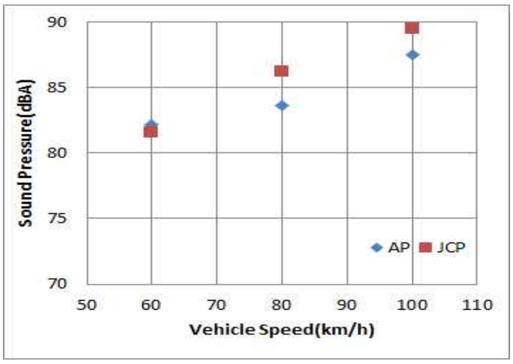
Figure 5 presents the analysis result of the pass-by measurement by vehicle type and pavement type. Figure 5 shows that the influence with an increasing vehicle speed (every 10km/h increase) was 1.2 dB(A) for passenger car, 1.5 dB(A) for van, 1.6dB(A) for bus and 1.7 dB(A) for truck. The result proves that size of vehicle positively influences an increase in noise level in the surrounding areas. In terms of pavement type, it appeared that joint concrete pavement has bigger influence than asphalt pavement.



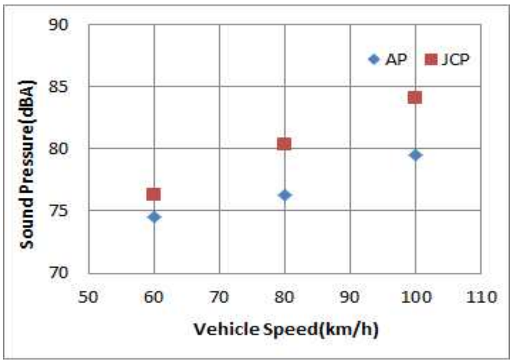
(a) Passenger car



(b) Van



(c) Truck

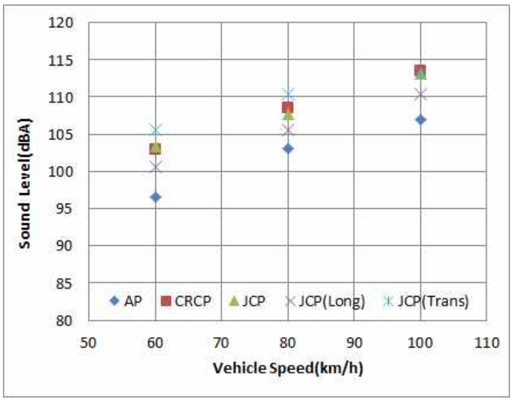


(d) Bus

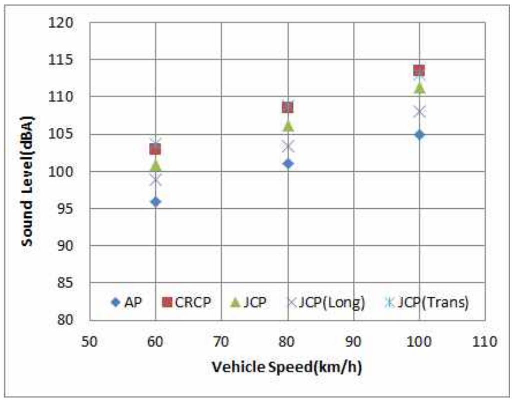
Figure 5 – Pass-by Analysis Result

3.2 NCPX Analysis

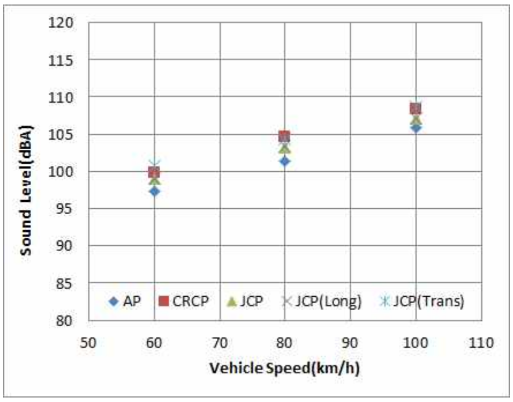
Figure 6 shows the analysis result of the NCPX measurement by vehicle type and pavement type. As shown in the figure 6, the influence by speed increase (every 10km/h increase) was 2.4dB(A) in case of passenger car and van and 2.1dB(A) in case of bus and truck. It is assumed that noise level is more influenced by tire size and tread than car size as the data was directly collected from near tire. In terms of pavement type, concrete pavement has bigger influence than asphalt pavement. However, truck has a relatively smaller deviation by pavement type and it is considered that the smaller deviation as the distance between locations where NCPX sensors are installed was relatively wide.



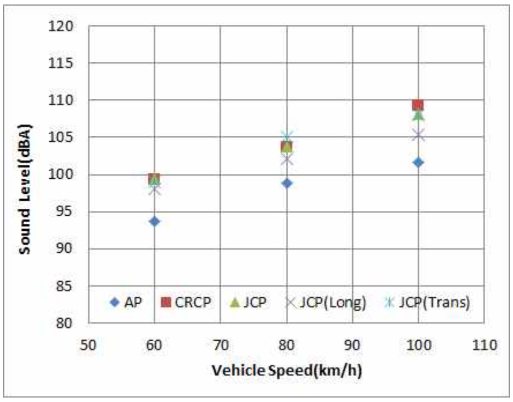
(a) Passenger car



(b) Van



(c) Truck



(d) Bus

Figure 6 – NCPX Analysis Result

Table 2 shows the summary of field measured noise and Cadna-A software simulation result. The research was conducted on an individual vehicle and the simulation was conducted to analyze mixed traffic. Comparing pass-by result and simulation value, they are three times different, which is considered to be caused by different pass-by position and different conditions.

Table 2 – Analysis Result of Field-Measured Noise and Simulation Noise   Unit : dB(A)/km/h

Vehicle Types	NCPX Noise Variation	Pass-by Noise Variation (7.5m/1.2m)	Simulation Noise Variation (10m/1.5m)
Passenger car	0.24	0.12	0.05 (Measured values by mixed traffic)
Van	0.24	0.15	
Bus	0.21	0.16	
Truck	0.21	0.17	
Average	0.23	0.15	

4. CONCLUSIONS

The research aims to analyze the relations between vehicle speed and noise level by measuring noise generated from each car on a road with the methods of NCPX and Pass-by. The research findings are summarized as follows.

1. Noise level of four different cars were measured on highway with the methods of pass-by and NCPX. Three sessions were conducted at different speeds of 60km/h, 80km/h and 100km/h and the pass-by point is measured as 7.5m in distance and 1.2m in height from the center of test car.

2. The analysis results an increase of around 1.5dB(A) in cased of pass-by per every 10km/h increase and around 2.3dB(A) in case of NCPX and 0.5dB(A) in simulation and concrete pavement shows bigger noise level than asphalt pavement.

3. Passenger car and van shows bigger increase in tire/pavement proximity noise by speed and bus and truck have a bigger increase in the pass-by noise measurement test.

4. Pass-by measurement result and simulation result have three times the difference and it is considered that the difference is attributable to car driving type, pass-by position and driving conditions.

Based on the research findings, it might be one way to control vehicle speed in order to restrict traffic noise in residential areas. It is also necessary to study changes in noise level through a further research on vehicle platoon.

ACKNOWLEDGEMENTS

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