한국소음진동공학회 창립 20주년 기념 2010년 춘계학술대회논문집, pp.121~122

Simulated Indoor Pass-by 시스템의 측정과 검증

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1. INTRODUCTION

The pass-by noise measurement is the activity to measure the noise emission of road vehicle under the acceleration condition. This measurement is mandatory to the automotive manufacturers for the model certification. For this reason, International Standard Organization, i.e. ISO, regulates the measurement, analysis procedures, as well as the reporting format. Of course, this measurement could be one of the most important activities of trouble-shooting for the mass-production cars, for example, tyre noise and exhaust noise… The pass-by noise measurement method should be designed to meet the requirements of simplicity, as far they are consistent with the reproducibility of the results. Also, the pass-by noise measurement should be done in an extensive open space for type approval of commercial vehicles, and it should be measured on the manufacturing stage at the official test station. Thus, it has such an important meanings that the certification of emission noise measurement checks before the mass production.

Mainly the indoor simulated pass-by noise measurement system is the tool to make measurement and analysis simple and reliable for not only trouble-shooting, but also development procedure. This measurement must be available in room where the size does not allow to setting up the microphones in 7.5m distance from the center line of both sides.

There are several assumptions for this method, that the noise is coming from one point, i.e. acoustic center, independent from frequency and the microphones are placed in the far field so the distance law is applicable to this measurement. In order to consider the moving source effect, the Doppler correction is applied to this measurement, as well.

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2. THEORETICAL BACKGROUND

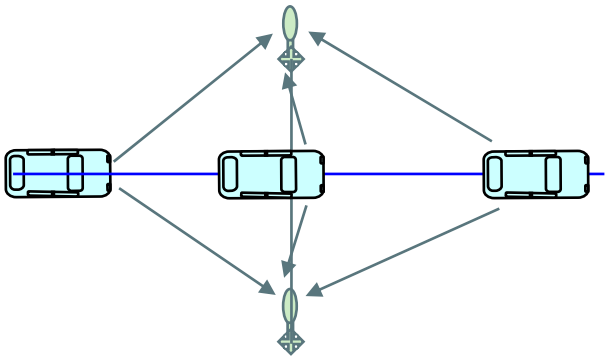

Fig. 1-1 Field Pass-by Noise Measurement

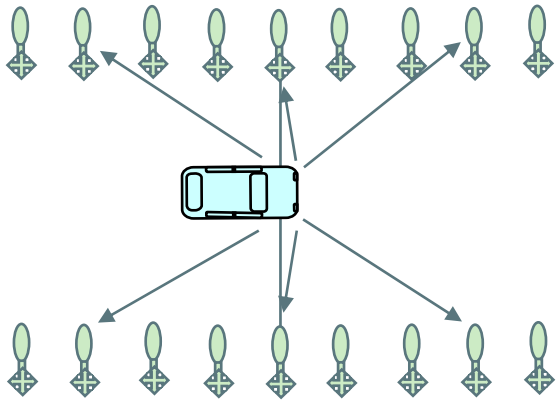

Fig. 1-2 Indoor Pass-by Noise Measurement

Fig. 1 Comparison of Pass-by Measurement system

In the field pass-by noise measurement, the system measures the noise that is propagating from the moving source, depending on the position of the car on the test track, like Figure 1-1. But in the indoor pass-by noise measurement, the car cannot move. So the measurement array is necessary to measure the moving source effect with the standing car. The microphone array measures the noise that is propagating from the standing source, but various directions. The each noise measured at the microphone array is corresponding to the position of the car on the field pass-by noise measurement, like Figure 1-2.

3. SIGNAL PROCESSING

3.1. Signal Selection

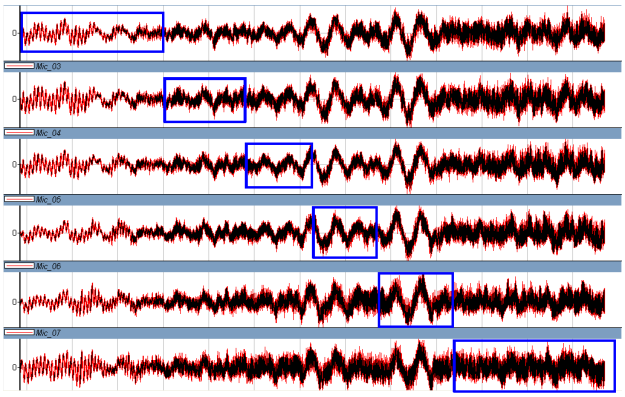

Fig. 2 Signal Processing

Figure 2 shows the measured data by the microphone array. The data measured by the microphone array have the limited information corresponding to the car passing timing. The car passing timing can be calculated by the car speed information, which is measured from the chassis dynamometer. The measurement is done during the acceleration condition, the acquisition timings are different from the microphone position. For example, the acquisition timing of the entrance part of microphone is longer than that of the escape part. The acquisition signals, which are sampled by each measured data is synchronized to one time signal.

4.2. Signal Synchronization

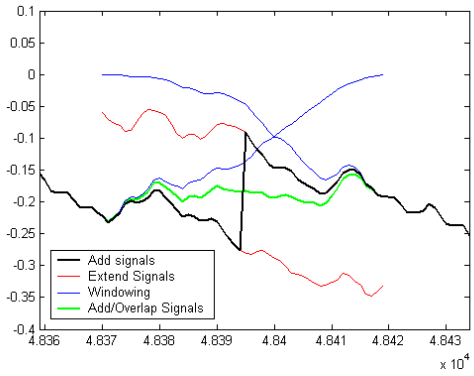

Fig. 3 Overlap & Add Transition

The Figure 3 shows the signal synchronization of the overlapped part. The time windows are used to minimize the signal processing error. In this figure, the black curve denotes the signal before processing, and the green curve denotes the signal after processing. As shown in figure, this signal synchronization gives the much smoother curve. This signal processing is extremely important, because the signals are handled in time-domain and can be heard after synchronization.

Figure 4 shows the measured signals with microphone array in time-domain. The below figure shows the synchronized time signal based on the above signal processing method.

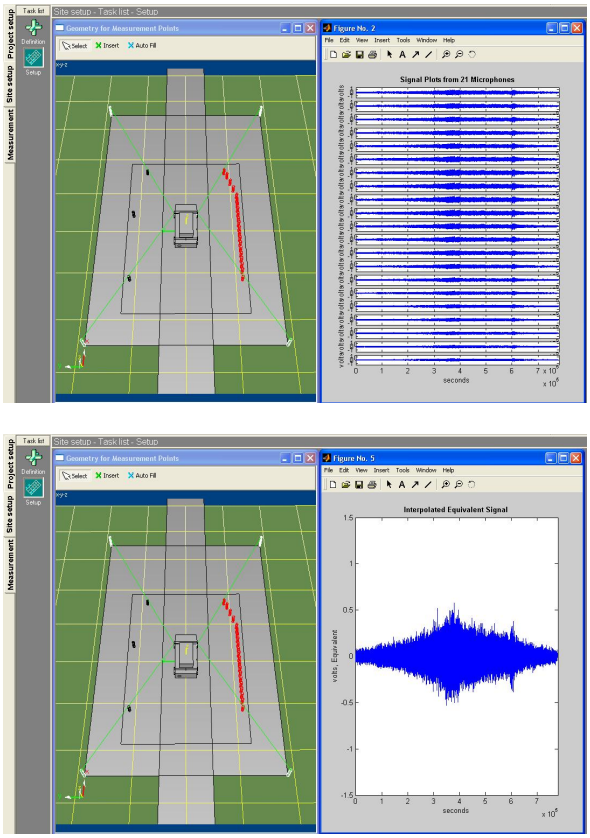

Fig. 4 Measured and synchronized time signals

4. CONCLUDING REMARKS

Pass-by noise measurement test procedure is recommended by international standards, i.e. ISO 362, SAE 1470,..

The proposed Indoor Simulated Pass-by Noise Measurement System can be used for the purposes of R&D and trouble-shootings.

If the simulated indoor pass-by noise measurement system can be combined with some noise source identification techniques, i.e. STSF(Spatial Transformation of Sound Field) and Beamforming, the specific results to identify the noise source, which cannot be given by the field pass-by noise measurement.