Railway noise impact assessment: An overview of the Railway Noise and Vibration Research project in South Korea

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ABSTRACT

Technology development for sustainable low noise railways, a consortium project funded by the Ministry of Land, Infrastructure and Transport of South Korea, has aimed to develop new technology for reducing railway noise and vibrations. One of the goals of this project is to establish guidelines for impact assessments on railway noise. Changes in people's perception of noise have elicited changes in approaches to the development of technology to reduce railway noise. Prior to formulating guidelines, research on procedures to measure railway noise, an impact assessment on people exposed to railway noise, and the selection of measures to evaluate railway noise impact must be conducted. This paper presents an overview of part of the project and the preliminary results of establishing guidelines for railway noise impact assessment. The results of this research are expected to contribute to the development of the effective methods and technology for reducing railway noise.

Keywords: Railway, Noise, Vibration, Annoyance, Noise impact assessment

1. INTRODUCTION

For the development of the railroad industry, eco-friendly railroad technology development considering third party risk as well as users of railroad industry technology is essential. Especially, the railway has eco-friendly merits in terms of energy saving and carbon dioxide emissions, but problems such as environmental pollution by noise and resulting human risk have continued to increase for the last few decades, and it is expected that this trend will continue in the future.

With changes in perceptions of noise, there is a limitation only with the existing development of noise reduction technology regarding physical quantity, and thus, it is necessary to develop a railway noise reduction technology based on the understanding of men's subjective reactions to noises and an evaluation method to quantitatively evaluate the effects of the reduction technology.

With the support of Railroad Technology Research Project by the Ministry of Land, Infrastructure and Transport, this study aims to develop a railway noise reduction technology, analyze the status of various civil complaints and the causes for them, develop an evaluation method of railway noise based on sensitive engineering according to characteristics of each noise source for an integrated evaluation of physical, affective reduction effect of the railway noise reduction technology and develop a comprehensive evaluation manual of the railway noise reduction technology. Therefore, applying this to various railroad areas in the future is expected to contribute to developing a technology with which effects on practical noise reduction can be felt and establishing related policy.

2. NOISE IMPACT ASSESSMENT

2.1 Railway noise annoyance

Since World Health Organization (WHO) proposed %HA, the percentage of the population that is

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highly annoyed as the indication of assessment of human health risk by noise, many researchers drew the %HA response curve of various environmental noises, and domestic studies also have presented annoyance models of traffic noise.

Some European countries apply 'railway bonus' to standard for the control of railway noise, which is a reduction of standard for railway noise by about 5dB considering the lowest point of reaction of displeasure to railway noise, but in the result of domestic research, reaction of displeasure to railway noise was considerably higher than that to road traffic noise, which is consistent with the research result in Japan, so it was reported that 'railway bonus' cannot apply to South Korea and Japan. In addition, according to the result of a study published by Korea Railroad Research Institute, noise characteristics vary greatly depending on railroad vehicles and track conditions, so even in the railway noises with the same continuous equivalent perceived noise level, there are significant differences in reaction to annoyance depending on the variability of sound, high-frequency characteristic and sound quality, etc.

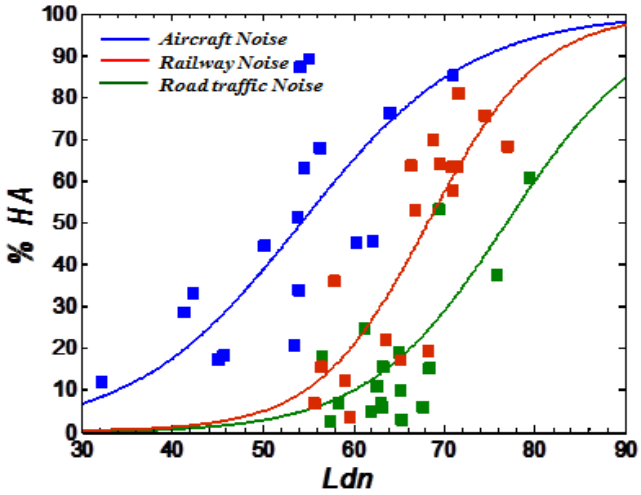

Figure 1 – %HA response cuves for transportation noise (Lee et al., 2008)

While quite many studies have been conducted on the relations of railway noise and noise impact in Korea, very little is addressed on the guideline of assessment method of railway noise impact. Guidance for the assessment of human response to railway noise varies according to non-acoustical factors as well as acoustical factors and there is currently no consensus as to the most appropriate evaluation index of railway noise impact and appropriate method of railway noise measurement for impact assessment.

The overall objective of the project - Technology development for sustainable low noise railways – is therefore to deduce an evaluation index and develop an evaluating procedure for measuring railway noise impact in order to develop the guideline for assessing railway noise impact. Furthermore, the evaluating method might be used for verifying the effect of railway noise reduction technology on residents living in the vicinity of railway lines.

2.2 Research procedure

Based upon a review of recent researches we followed a procedure generally recommended by many researchers and modified to meet our goals of this project. In figure 2 a general overview of the proposed research overview is provided, indicating the 7 steps of research on railway noise impact assessment and its applications.

(1) Status survey, (2) Railway noise DB construction, (3) Selection of the appropriate evaluation indices, (4) Analysis of evaluation factors, (5) Sound synthesis for psycho-acoustic experiment (6) Evaluation of subjective response to railway noise, (7) Development of railway noise impact model

Status survey for identifying the annoying components of railway noise were conducted for the residents living in the vicinity of railway lines and the train passengers and noise measurement for the deduction of the evaluating method for railway noise impact in the first year of this project

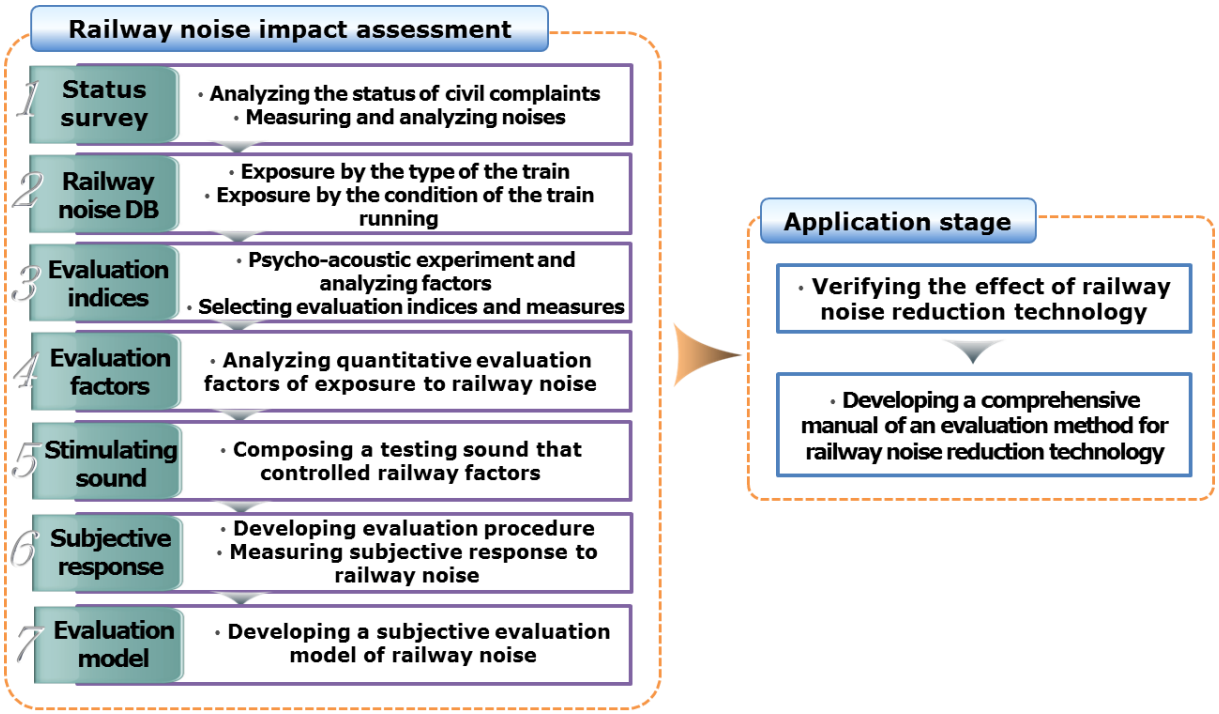

Figure 2 – Overview of research procedure for railway noise impact assessment

2.3 Status survey

In order to analyze the status of civil complaints to railway noise, status survey were conducted in the surrounding areas of 3 different train stations. Respondents to the survey was 100 and they described passing noise and approach noise as main noise sources causing noise annoyance. Several terms were selected by the respondents as appropriate descriptors for railway noise: concerned, loud, offensive, noisy, alarming, tuneless, and disturbed.

2.4 Noise measurement

Noise measurements were made simultaneously with single microphone and Head and Torso recording system (Brüel & Kjæ r Type 2250, Brüel & Kjæ r Type 4100, and Headacoustics MHS & Squadriga) at train station and near the track side.

Figure 3 – Noise measurement (left: train station, right: track side)

In figure 4, the loudness and spectral density level of freight train noise of 80km/h were analyzed

for both measurement signals obtained by single microphone and HATs, and the level difference were found between monaural signal and binaural signal.

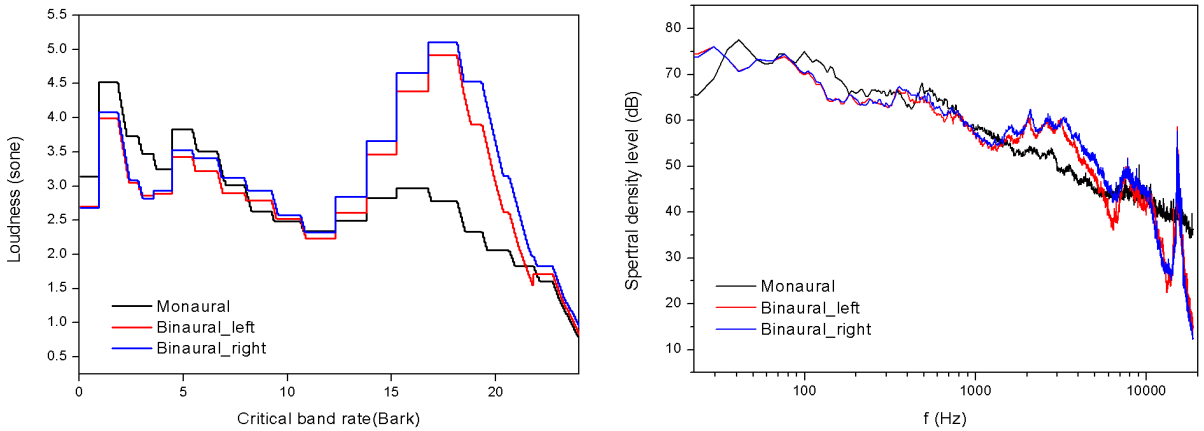

Figure 4 – Loudness and spectral density level of freight train noise

2.5 Next steps

The railway noise evaluation model has a merit that it can understand the result of railway noise reduction technology development for the creation of a quiet environment in advance. Development of a forecasting model should be based on systematic and precise measurement and analysis of various factors considering affective evaluation, and it is required to set up an evaluation plan considering the environment of the group exposed to noise in the process of measurement and analysis. Psycho-acoustic approach should first be required, which looks into perceptions of noise through the understanding of the status of civil complaints or prior questionnaires, and an acoustic approach grafting an analysis based on affective evaluation onto the measured sound-source data..

Understanding civil complaint factor, which is the basic data of research on the standardization of affective evaluation is a very important step, and it is necessary to carry out an impact assessment with local residents within the area of noise influence and establish basic data of the form of questionnaires and evaluation indices from that.

For the standardization of the method of affective evaluation of noise, it is necessary to draw out factors through an analysis of the factors based on the result obtained through the affective evaluation and affective evaluation indices, and through a test of the subjects' affective reactions, an affective evaluation model of railway noise is developed.

3. CONCLUSIONS AND FUTURE ACTIONS

In developing a railway noise reduction technology, the goal of noise reduction may be presented and evaluated with numerical values in terms of physical quantity, but affective, subjective evaluations also are very important, which shows the noise reduction effect of the application of the developed technology felt by the people who are actually affected by railway noise such as railway passengers or trackside residents. Since the evaluation of noise may differ depending on various factors, not only model of the train, driving conditions and track conditions, but also recipients' subjective attitude to railroad traffic or sensitivity to noise, this study attempts to establish a database of various railway noises and develop an integrated evaluation method.

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