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Effects of apartment building façade and balcony design on the reduction of exterior noise

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Abstract

The effects of building façade and balcony design on the reduction of exterior noise were investigated by measuring the noise from traffic at an apartment complex located by a road side as well as the sound field characteristics of an area surrounded by four apartment buildings. The efficiency of different balcony forms for reducing exterior noise was determined using a 1:50 scale model and a single spark source. It was found that parapets were more effective in reducing exterior noise than lintels. Based on the measurements of the parapet used for this study and the absorptive materials in the scale model, a maximum noise reduction of 23 dB was obtained. Lastly, a computer simulation was conducted in order to predict the noise reduction level of lintels and parapets. The results of the simulation were compared to the results of the scale model test. Our results indicate that this method of exterior noise reduction can be useful in high-rise buildings where tall barriers cannot be built.

Keywords: Exterior noise; Facades; Balcony; Noise reduction; Scale model; Computer simulation

1. Introduction

Multi-residential buildings are the most common type of dwelling in Korea, and approximately 40% of the population lives in high rise apartment buildings. In a mega city like Seoul, many buildings are exposed to severe exterior noise due to their proximity to roads and train railways. While legal requirements and guidelines that limit exterior noise levels do exist, a recent report [1] found that six major cities in Korea exceed the legal limit and that the noise levels of high rise buildings were most severe for upper stories. This report also showed that existing sound protecting treatments, such as sound barriers, are limited in their ability to reduce exterior noise levels.

Many researchers have investigated the screening effect of balconies using either scale models or computational studies. Cheng et al. [2] investigated the performance of the lintel using Macdonald's theoretical prediction and the image receiver theory, showing that the average predicted insertion loss provided by an absorptive top screen is 20 dB at 1 kHz and 25 dB at 2 kHz. Hotherall et al. [3] calculated the sound pressure level relative to the free field level within balconies using a two-dimensional boundary element numerical model. Their study found that treatment of the ceiling or the rear wall of the balcony was the most efficient method of reducing noise. In addition, Hossam El-Dien and Woloszyn [4,5] tested several different forms of balconies, and Tang [6] examined the insertion loss and noise spectrum of a rectangular balcony using a scale model.

Most previous studies mentioned above define exterior noises solely as traffic noise. Further, previous scale model tests and simulations were not conducted in an apartment complex, but rather in a single building. However, most multi-residential buildings in Korea are built as a complex

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consisting of 10–30 buildings, and in such an apartment complex, other noises, such as those produced from vehicles entering and exiting an underground parking lot or from a nearby outdoor market held in that area, may be produced in the surrounding area. The effectiveness of different balcony types as screening devices for these noises has not yet been investigated for an apartment complex.

In the present study, a 1:50 scale model test was carried out to investigate the noise reduction offered by the combination of various balcony treatments for a single building and an apartment complex. The treatments consist of a parapet, lintel, absorber, and balcony ceiling angle. In addition, a computer simulation was conducted to validate the scale model results. The general screening effects are expressed in terms of A-weighted sound levels [4–7].

2. Field measurement

Field measurements were conducted to investigate traffic noise levels and acoustic characteristics of apartment complex located near a road.

2.1. Traffic noise measurement

Traffic noise was measured in apartments that were 60 m away from a six-lane road, and each of the buildings in which measurements were taken consisted of fifteen stories. There were two 4–5 story buildings between the road and apartments, as well as an outdoor driving range across the road from the apartment complex. It was assumed that traffic noise could radiate to the apartments despite possible interference from the other buildings.

As shown in Fig. 1, traffic noise measurements were carried out in the balconies on the 1st–5th, 7th, 9th, 11th, 13th and 15th stories of buildings 107 and 108, which were exposed to the most amount of noise during the daytime (06:00–22:00) and nighttime (22:00–06:00).

2.2. Traffic noise measurement results

As shown in Figs. 2 and 3, the levels of traffic noise at each building, except for the 9th floor balcony of building 107, were less than the maximum allowable exterior noise

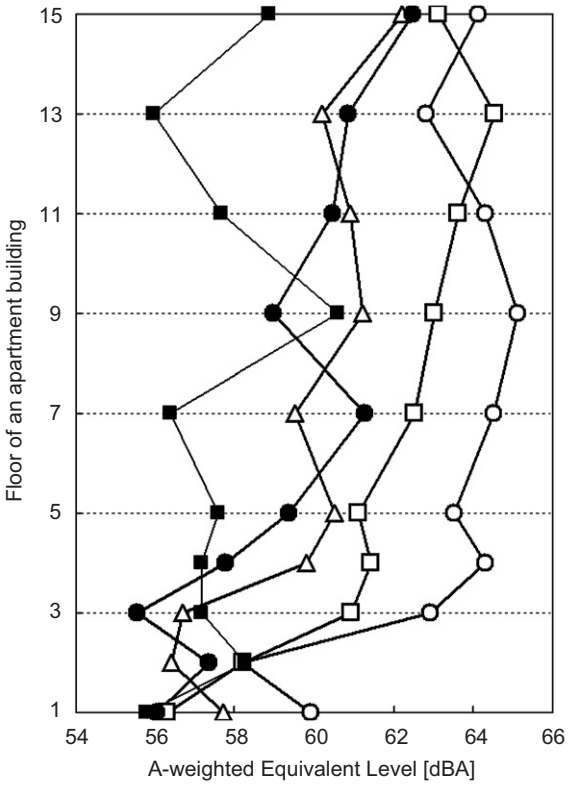

Fig. 2. Traffic noise at the balconies of building 107, ○: 15:00–17:00, □: 18:00–20:00, △: 20:00–22:00, ●: 22:00–24:00, ■: 24:00–02:00.

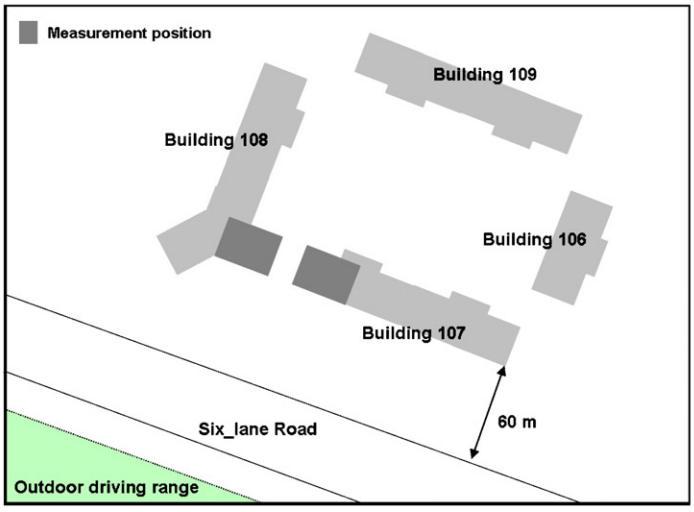

Fig. 1. The apartment complex in which traffic noise was measured.