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Use of vegetation for abatement of road traffic noise in a 1:10 scale street model

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Sound propagation over the building elements has been evaluated to measure the traffic noise level from the street canyon the adjacent courtyard. In this study, a 1:10 urban scale model was constructed to evaluate the noise abatement by use of vegetation as sustainable means. The model materials were selected by measuring absorption coefficients and ground impedances in a 1:10 and a full scale testing environment; the ground, foot path, low barrier, façade and roof were treated with vegetation. Sound pressure levels and reverberation times were measured in the scale model and were compared with the results of computer simulation.

1 Introduction

Green urban spaces have been suggested for many years along with the sustainable design concept. Recently, the vegetative elements such as green wall and green roof have been applied to the building elements. Even though acoustical scale models of the urban space such as street canyons were widely adopted since late 1990s [1-2], the acoustical influences of vegetation on urban spaces have not been fully investigated. In this study, the scale model materials were selected by the measurements of absorption coefficient according to ISO 354. Accordingly, the configurations of an urban scale model and its evaluation methods were investigated. In addition, a model selection process of tree was described in in-situ RT measurements with a tree.

2 Urban scale model configurations and measurements

2.1 Configurations

1:10 scale street model represented a European urban space exposed to road traffic noise in a street canyon the adjacent to the courtyard. Total length of the street was 60m; height of the buildings was 10 m for the three stories, and the width of the road was 10m for the 2 lanes as shown in Figure 1. Evaluation of sound propagation was carried out in the street canyon and diffraction by the buildings was evaluated in the courtyard. The structure of the model was made by 18 mm thick unpainted MDF boards.

2.2 Measurements and results

A high-voltage electrical spark source and 1/8" microphones (B&K 4138) were used for measurements in the street model as shown in Figure 1. 16 impulse responses for the street canyon with one source position and 21 impulse responses for the courtyard with three sound source positions were measured. The source was placed at 3m away from the building surface and the height was 1.2m from the ground.

Figure 2 shows the reverberation time (RT) and early decay time (EDT) in the street canyon. With the increased source to receiver distance by 25m (from 5m to 30m), RT was increased by 0.75 s and EDT was increased by 1.12s. As the parallel and smooth building surface enhanced the reflections, the RT and EDT increased by the S-R distance increased.

Figure 2 shows SPL decrease by the sound propagation in street canyon. The largest level difference was 9.8dB from 5m receiver to 30m receiver from the source positions.

These results were ideal case with minimum diffusing elements and absorption materials. The results will compare to both rigid and vegetation façade in the street canyon. For the courtyard evaluation, sound pressure levels of each receiver positions were similar at each position.

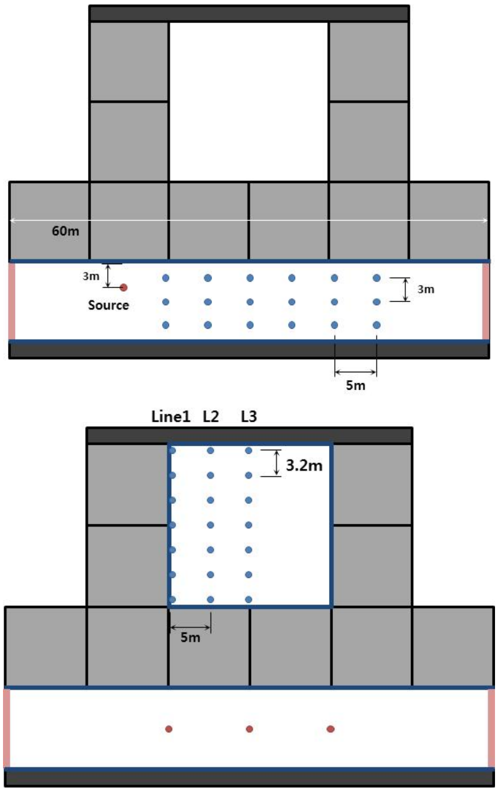

Figure 1: Model configuration with Source, Receiver position

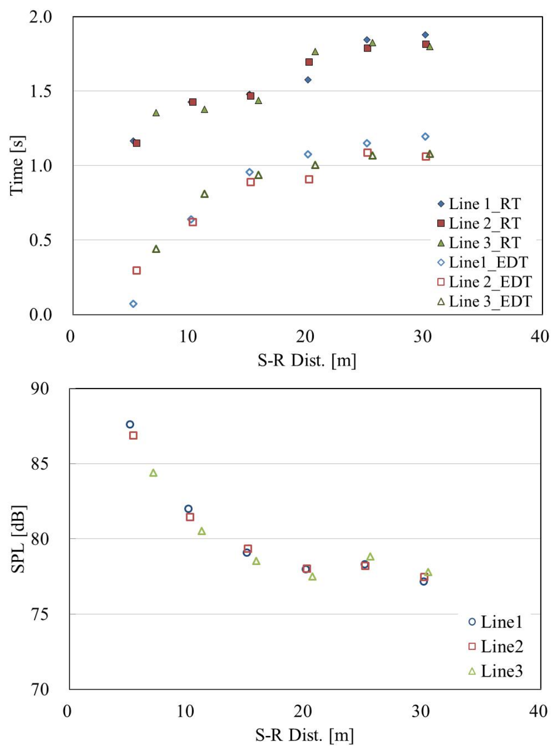

Figure 2: RT, EDT and SPL values at the the street canyon by the source to receiver distance

As vegetated screen and green roof install building roof, the effect of green materials on the courtyard is being evaluated in the courtyard.

3 Absorption coefficients

3.1 Methods and Results

Measurements were performed in a 254m^3 reverberation chamber according to ISO 354. A high-voltage electrical spark source and 1/8" microphones were used. Two spark source and six microphone positions were measured for three times. In these measurements, two types of building materials were measured, which were windows and rigid brick facades for the reference case to compare the effect of vegetation for noise abatements.

The target absorption coefficients were obtained from the previous studies. The selected α of window was for large panes of heavy plate glass [4]. 2mm thick acryl with 20mm air backing was selected as the window model material. In case of rigid facade, brick walls were designed with unglazed brick [4], and 16mm thick acryl was selected as the model material.

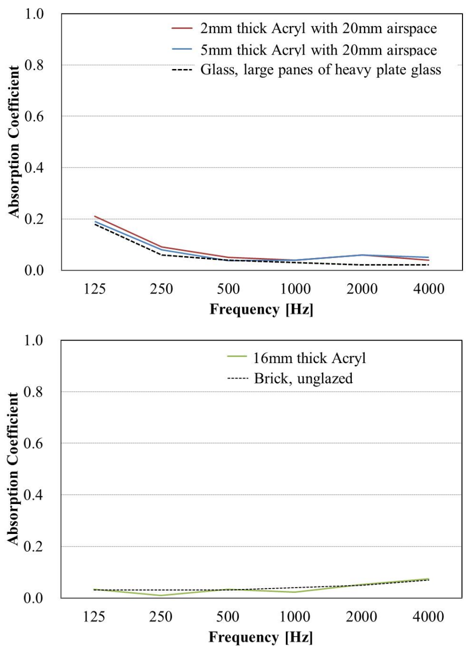

Figure 3: Absorption coefficient of 1:10 scale model materials

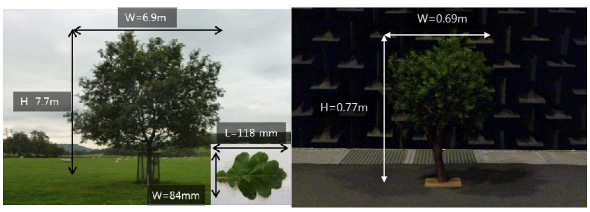

Figure 4: Real scale tree in Sheffield and 1:10 scale model tree

4 Tree measurements for sound dispersion

4.1 Methods and Results

Sheffield University measured trees in open field to investigate the effect of a single tree on sound dispersion and RT [3]. Impulse responses were obtained at 10m from the tree, and the sound source at the other side was 10m from the tree as well. In this study, 1:10 scale model trees were reproduced as similar dimension as the real scale tree selected by Sheffield University. In anechoic chamber, the absorption of the tree model was measured with grass material, Polyurethane 10mm thick.

The RTs with tree and without tree were shown in Figure 5. RT increased with tree at above 1 kHz frequency bands.

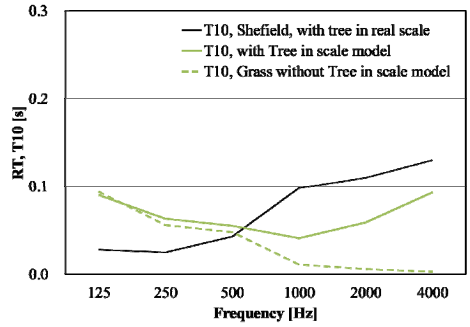

Figure 5: Comparison of RT with and without Tree in 1:10 scale model

5 Conclusion

In this study, an urban 1:10 scale model was produced to evaluate sound propagation in the street canyon and diffraction noise to the courtyard. Scale model materials were selected for measuring abatement of road traffic noise in European cities with vegetation. Ground impedances were measured to select the scale model ground surface as well. In addition, the effect of greenery materials on the reduction of road traffic noise will be further evaluated in this model.

Acknowledgments

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References

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