POLITECNICO DI TORINO
FIRST SCHOOL OF ARCHITECTURE
Master of Science in Architecture Construction City
Honors theses

Acoustics of theoretical urban open spaces through the insertion of vegetation as noise abatement mean.
Parametric studies and practical guidelines

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Vegetation has benefits in increasing the health and well-being of citizens from different viewpoints. The aim of the thesis is to investigate the effectiveness of vegetated façades from an acoustical perspective. Noise pollution, in fact, is a major environmental problem within the EU and during the last years vegetation was tested as a means of noise abatement. This work seems to support the main objectives of the European project named HOSANNA, in which I was enrolled, by making applicable some prediction methods to abate urban noise, delivering a good practice guide for the end-users and demonstrating that designing green coverages can minimise the noise impact on citizens.
The thesis focuses on the effectiveness of three plants (Fig. 1) in terms of reduction of sound pressure level (SPL) in two theoretical urban squares, namely an ideal rectangular and an ideal octagonal, with all their architectural features like height of buildings, squares/streets dimensions, type of façade(Fig. 2).



	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
hedera helix abs. coef.	0.03	0.08	0.00	0.08	0.22	0.40
nephrolepis exaltata abs. coef.	0.09	0.23	0.49	0.48	0.49	0.47
vegetated wall abs. coef.	0.60	0.60	0.70	0.70	0.70	0.70
scattering	0.00	0.00	0.13	0.14	0.21	0.49

Fig. 1 – Plants used and acoustic properties

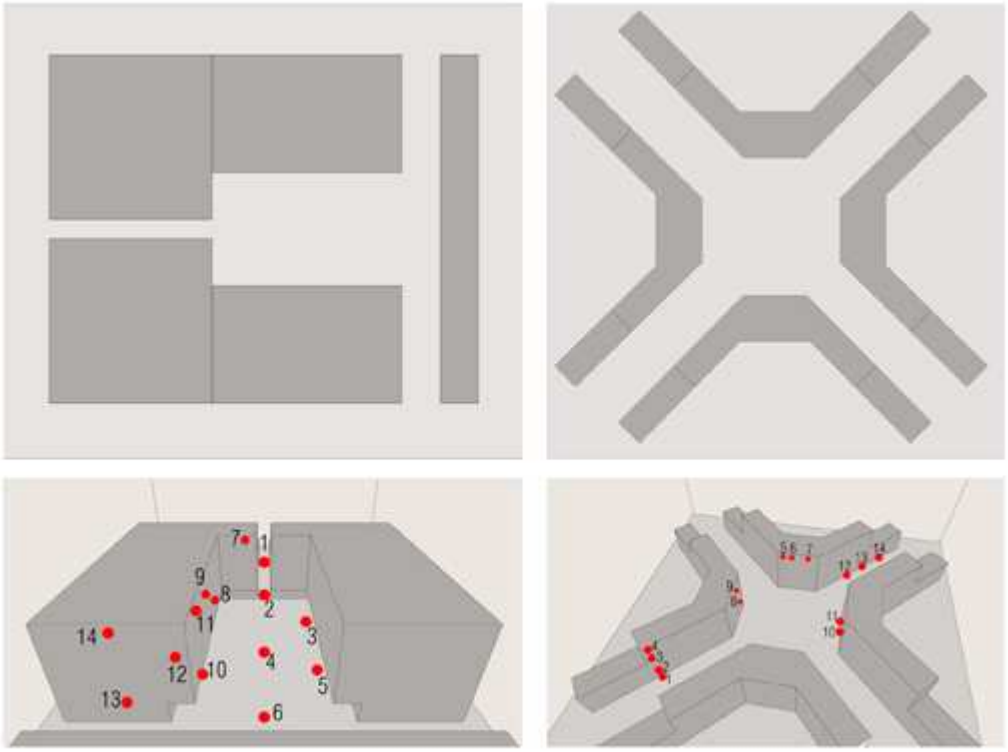

Fig. 2 – Ideal rectangular square and ideal octagonal square

Four aspects of the use of vegetated coverages were evaluated: effect of the *amount* of vegetation, effect of changing in the *scattering coefficient* of vegetation, effect of vegetation in *different receiver positions* and effect of vegetation on *groups of receivers*. Variations in terms of SPL were found with the use of three software: CATT-Acoustic, CRR (Combined Ray-tracing and Radiosity) and Odeon.
The work is structured in four chapters. The *first chapter* is background about definitions, standards and introduction on the uses of vegetation in architecture. The *second chapter* details laboratory experiments and studies done to define traffic noise. *Chapter three* is about parametric studies: results of the vegetated layouts are provided. *Chapter four* is on practical guidelines and on the study of technological solutions that integrate green coverage with architecture. *Conclusions* and an overview on *further works* complete the dissertation.
Ivy and *vegetated wall* were used in the ideal rectangular square: this proved that a variation in the scattering coefficient does not affect SPL averaging values at any frequency, while the increase of the absorption coefficient of vegetation plays a primary role in obtaining high values of insertion loss (IL) especially in the farthest receivers where SPL is reduced of 4-5 dB.

An increase of the amount of vegetation used can give higher values of IL, though it is not a linear increase for both specimens. Concerning the location of vegetation in the square, on angles or under the arcades, the same tendency of IL curve is given by ivy or vegetated wall, and with the decrease of the distance between source and receiver IL tends to decrease reaching similar values for both plants. Vegetated wall under the arcades gives IL averaged values that are higher by 0.5-1 dB compared to averaged IL obtained with vegetation on angles. Last, a deep dependency between IL and the influence of the scattering coefficient of vegetation at high frequencies is proved, while at low frequencies the absorption coefficient tends to prevail on SPL reduction.
The ideal octagonal square gives lower values of IL than the previous case. *Ivy* and *nephrolepis exaltata* were used in this analysis. The highest IL, of about 2 dB, is reached using 4680 m^2 of nephrolepis all over the square façades and on half the façades in the side streets. This study confirms that at high frequencies the absorption coefficient has a lower effect in the decrease of SPL, while scattering coefficient plays an important role.
Due to a lack in the acoustic software for the evaluation of outdoor spaces, CATT's results were compared to the one obtained with CRR and Odeon. This investigation shows an agreement in terms of IL, so an objective analysis on the effectiveness of vegetation as noise abatement mean is reached(Fig. 3).

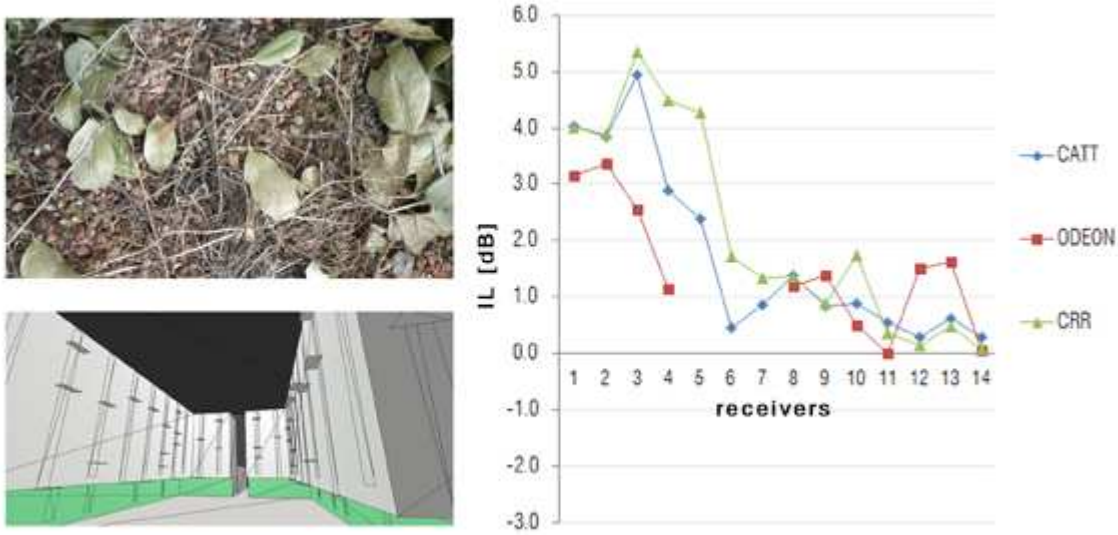

Fig. 3 – Comparison between results in terms of IL obtained through the use of three software for acoustic simulations: the given values are an example and are referred to the vegetated wall used under the arcades in the case study of the rectangular square

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