

# AN ACOUSTICAL COMPARISON OF TWO ATRIUM SPACES

J.S. Bradley<sup>a</sup> and Y.K. Oh<sup>b</sup>

<sup>a</sup> Acoustics Laboratory, National Research Council, Montreal Rd, Ottawa, K1A 0R6

<sup>b</sup> Dept. of Architecture, Mokpo National University, Muan, Chonnam, 534-729 Korea

## Introduction

This paper reports the results of comparisons of the acoustical conditions in two architecturally different atrium spaces. The East atrium is a long and narrow atrium with open plan office areas opening directly onto the three levels of the atrium space. The Small atrium has a small octagonal plan, is three floors high and serves as an entrance to a large office complex. These studies were part of a larger project to examine various aspects of atria and included acoustical tests in 10 atrium spaces.

Acoustical impulse response measurements were made in each atrium using an approximately omni-directional source and a maximum length sequence signal. Various acoustical measures including decay times and sound levels were obtained from the impulse responses.

## The East Atrium

Figure 1 compares average early decay times, EDT, and reverberation times, RT in the East atrium. The results are characteristic of many atrium spaces with the largest decay times at mid-frequencies. They decrease at lower frequencies due to the sound absorption of the glass and other materials, and at higher frequencies due to air absorption. EDT values are shorter than RT values indicating that the decay is not completely linear and that the sound field is not very diffuse.

Average values of the measured early-arriving and late-arriving relative sound levels showed the early energy to be several decibels stronger. This suggests that if background sound levels are low there will be reasonably good speech intelligibility within this space, which was confirmed from measures of speech intelligibility.

Figure 2 shows relative sound levels,  $G$ , at 1000 Hz versus source-receiver distance in this atrium. For comparison, the predictions of simple diffuse field theory and Barron's

revised theory are also shown. At distances up to about 30 m there is some agreement with Barron's theory but with considerable scatter because some positions were partially screened. At larger distances, measured values consistently fall below predictions. These results are different than those in large auditoria because of the larger distances and more similar to measurements in industrial spaces.

## The Small Atrium

The average measured decay times in the Small atrium peak at 250 and 500 Hz. This was because the medium and higher frequency decay times were reduced because of the presence of a large area of porous sound absorbing material.

Measured early relative sound levels were again a few decibels higher than later arriving sound levels. However, the total relative sound levels were 8 or 9 decibels higher in this smaller atrium.

The propagation of sound within the Small atrium was quite different than in the East atrium (Figure 2). For sources and receivers on the main floor, the variation of sound levels with distance was similar to simple diffuse field theory. For propagation to receivers on the upper two floors, sound levels decreased at approximately 6 dB per doubling of distance. This suggests that the direct sound is dominant due to the large areas of sound absorbing material on the balcony faces.

## Conclusion

The common reverberant characteristics of atrium spaces are due to the low frequency absorption of the large areas of glass. The propagation of sound within atrium spaces depends on the geometry of the atrium and the placement of sound absorbing materials.

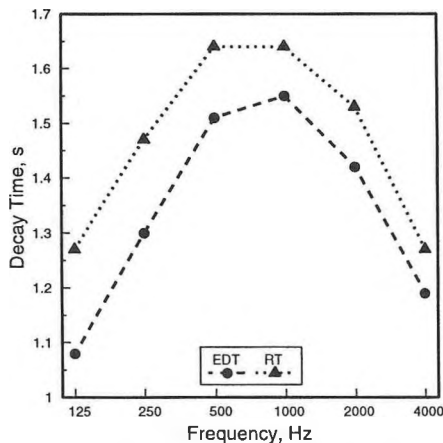


Fig. 1. Average decay times in the East atrium

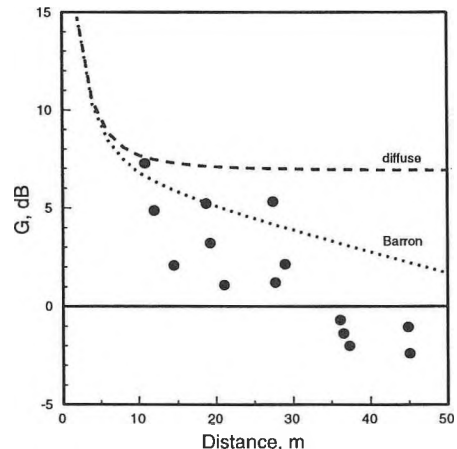


Fig. 2. Relative sound levels versus distance, East atrium.