THE ACOUSTIC RESEARCH IN THE DEPARTMENT OF ARCHITECTURAL SCIENCE RYERSON UNIVERSITY

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Résumé

Le laboratoire de la science du bâtiment dans le département de sciences architecturales a les capacités pour mener des expériences d'évaluation des propriétés de matériaux acoustiques. Quatre tubes d'impédance sont disponibles pour évaluer le coefficient d'absorption et un certain nombre de propriétés associées. Les tests utilisant un système a deux microphones ainsi que les tests utilisant un système à trois microphones peuvent y être effectués. Un soufflerie à échelle réduite peut être utilisée pour des expériences de localisation de sources. Modélisation détaillée par éléments finis, en utilisant COMSOL, peut être utilisé pour prédire la performance acoustique des silencieux passifs, les résonateurs de Helmholtz ainsi que la propagation du son dans des souffleries. La simulations Aero-acoustiques est également possible en utilisant le puissant logiciel "ACTRAN". Enfin, la recherche acoustique reliée au auditorium et salle sont réalisées en utilisant à la fois les outils de simulation ainsi que des études expérimentales. Les détails de la recherche seront mis en évidence dans ce bref résumé.

Mots clefs : propriétés des matériaux, aéro-acoustique, conception de contrôle de bruit

Abstract

The building science laboratory in the Department of Architectural Science has capabilities to conduct research activities in the field of room acoustics and noise control. Four impedance tubes, with both two-microphone and three-microphone systems, are available to evaluate the absorption coefficient as well as a number of other material properties. A scale model wind tunnel is also available for source localization experiments. Detailed finite element modelling, through COMSOL, are used to predict acoustic performance of passive silencers, Helmholtz resonators as well as sound propagation in the available wind tunnels. Similarly, aero-acoustic simulations are also possible by using the software ACTRAN. Finally, auditorium and room acoustic researches are conducted through simulations as well as through in field measurements.

Keywords: Room acoustics, material properties, aero-acoustics, noise control design

1 Introduction

The Department of Architectural Science (DAS) at Ryerson University has two faculty members whose teaching and research focus on acoustics and noise control.

Two acoustics courses catered to architectural science students are being offered at the undergraduate level. The third year course teaches basic acoustic materials on room acoustics and sound transmission. The fourth year course (also available to graduate students) deals with acoustics of performance spaces.

The main areas of the acoustics research are described below.

2 Architectural Acoustics

Sound represents one of the most valid and often underestimated ways to experience a space. The acoustics of heritage buildings is often crucial. This new attention to cultural heritage has fostered the study of the relationship between the architecture and its acoustics. Within this context, the acoustics of Italian historical buildings (mainly churches [1, 2] but also theaters [3]) was researched by Dr. Berardi over the last decade. Similarly, the music rooms were researched through both simulations and site measurements by Ramakrishnan and Dumoulin [4]. Room acoustics studies have been performed using both detailed analysis as well as software simulations with EASE, CATT and/or ODEON.

3 Acoustic Materials

The characterization and testing of new building materials and building systems is among the most active area of research in the DAS Acoustic Lab at Ryerson. Sustainability principles and new design criteria provide the impetus to study new systems composed of natural materials (mainly vegetative fibers) for sound absorption treatments [5]. Based on their microscopic configurations, both porous absorbing cellular as well as fibrous materials have been considered (Fig.1). Sound absorption, air resistivity, open porosity, and tortuosity measurements have been conducted and the results

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were used to develop theoretical model to predict the behaviour of these materials. In addition, the acoustic behaviour of nanotechnologies, such as aerogel, in room acoustic applications, has been of recent interest. Four impedance tubes (Fig.2) are available in the laboratory and the research is continuing to determine the effect of compression on porous materials [6].

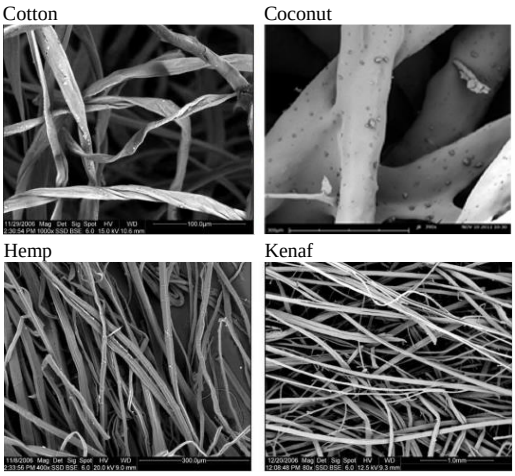
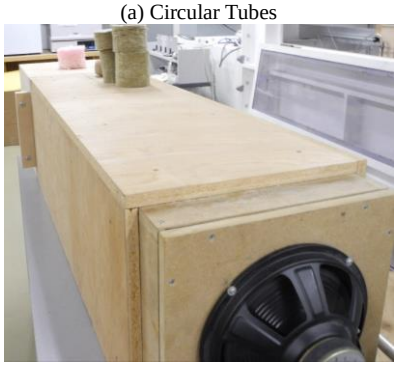


Figure 1: Materials studied for acoustic applications (from [5]).

(a) Circular Tubes



(b) Square Tube

Figure 2: Photos of the impedance tubes.

4 Aero-Acoustics

The acoustics lab has been gifted with a pilot wind tunnel (PWT) with a top speed of 250 kph. The PWT, shown in Figure 3, has been used to study the acoustical performance of wind tunnel components such as corner vanes and the use of Helmholz resonators to attenuate the very low-frequency circuit resonances. In addition, numerical calculations can be undertaken with the use of software such as COMSOL multiphysics and Actran. One such simulation study evaluated the acoustic performance of large corner vanes with varying treatments is reported in [7].

Figure 3: Photo of the pilot wind tunnel

5 Noise Control

Various aspects of noise control research have been conducted, such as the evaluation of the performance of elbow silencers [8]. Basic research in experimental methods of building acoustics is also a primary research area [9]. In addition, research is on-going in understanding wind turbine noise sources as well as realistic prediction methods [10].

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