8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

NUMERICAL SIMULATION OF SMART CELLS WITH A FRONTAL MICROPERFORATED WALL DEVISED AS SOUND ABSORBERS

*** A. Bermúdez[1], P. Gamallo[2], L. Hervella-Nieto[3], and A. Prieto[1]**

[1] Dept. de Matemática Aplicada, Universidade de Santiago de Compostela, 15782, Santiago, Spain
mabermud@usc.es, maprieto@usc.es

[2] Dept. de Matemática Aplicada II, Universidade de Vigo, 36310 Vigo, Spain
pgamallo@uvigo.es

[3] Dept. de Matemáticas, Universidade de A Coruña, Facultade de Informática, A Coruña, Spain
luisher@udc.es

Key Words: *Active noise control, smart materials, perfectly matched layers, finite element method.*

ABSTRACT

The aim of this work is to assess by means of numerical simulations the performance of a certain type of smart cells as sound absorbers. These prototype cells consist of parallelipipedic boxes with all of their faces rigid, except one of them, where a porous veil (or a serial combination of rigid microperforated plates) is placed (see [5]). In the back wall of the cell, there are disposed an array of planar loudspeakers (actuators) controlled by a finite number of microphones (sensors), which are placed in the interior of the box close to the frontal face (multichannel active control).

Firstly, we study the case of a single passive cell surrounded by an unbounded fluid domain. Since we restrict our study to the frequency domain, we will assume that both the porous veil and the microperforated plates can be modelled by a frequency-dependent impedance (see, for instance, [6] or [7]).

In order to compute the acoustic pressure field, we truncate the original unbounded domain of the scattering problem by using an exact bounded PML technique (see [1] and [2]) and then, the resulting weak problem is discretized by using a standard finite element method.

Finally, we use this numerical PML-FEM method to compute the performance of the multichannel active control system. In this control problem, instead of using the total power or intensity radiated by the cell as objective function to minimize, whose practical implementation would be unfeasible, the objective function only involves the values of pressure and velocity at a finite number of points inside the prototype (see, for instance, [8]).

Moreover, two types of active controls have been implemented following the ideas developed by Buyenne and Burdisso (see [3] and [4]) for a Kundt tube of plane waves with normal incidence.

More precisely, we use the “pressure release” control, which minimizes the pressure on the inner frontal surface of the panel, and the “impedance matching” control, whose objective is to recover the characteristic impedance from the quotient of the pressure and the normal velocity also on the inner face of the panel.

In the active and the passive cases, we compute the numerical pressure field for a given frequency, obtaining the frequency response of the smart panels. The numerical results computed with the three dimensional code are compared to those obtained analytically in the one dimensional case.

REFERENCES

[1] A. Bermúdez, L. Hervella-Nieto, A. Prieto, R. Rodríguez. “An exact bounded perfectly matched layer for the Helmholtz equation”. *C. R. Math. Acad. Sci. Paris*, Vol. **339**, No. 11, 803–808, 2004.

[2] A. Bermúdez, L. Hervella-Nieto, A. Prieto, R. Rodríguez. “An optimal perfectly matched layer with unbounded absorbing function for time-harmonic acoustic scattering problems”. *J. Comput. Phys.*, Vol. **223**, 469–488, 2007.

[3] S. Beyene, R. Burdisso. “Adaptive control of sound reflection”. *J. Acoust. Soc. Am.*, Vol. **97**, 3268, 1995.

[4] S. Beyene, R. Burdisso. “A new hybrid passive–active noise absorption system”. *J. Acoust. Soc. Am.*, Vol. **101**, 1512–1515, 1997.

[5] P. Cobo, M. Cuesta. “Hybrid passive–active absorption of a microperforated panel in free field conditions”. *J. Acoust. Soc. Am.*, Vol. **121**, EL251–EL255, 2007.

[6] R. Kirby, A. Cummings. “The impedance of perforated plates subjected to grazing gas flow and backed by porous media”, *J. Sound Vibr.*, Vol. **217**, No. 4, pp. 619–636, 1998.

[7] D. Y. Maa. “Microperforated-panel wideband absorbers”. *Noise Control Eng.*, Vol. **29**, No. 3, 77–84, 1987.

[8] P. A. Nelson, S. J. Elliott. *Active Control of Sound*. Academic Press, London, 1992.