

New methodology for vibroacoustic energy diffusion optimization by mean of distributed electromechanical devices.

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SYNOPSIS

The paper proposes a synthesis of different new methodologies for developing a distributed, integrated shunted piezo composite for beams and plates applications able to modify the structural vibro acoustical impedance of the passive supporting structure so as to absorb or reflect incidental power flow. This design implements tailored structural responses, through integrated passive and active features, and offers the potential for higher levels of vibration isolation as compared to current designs. Optimization tools for designing shunt circuits is presented and validated.

INTRODUCTION

Research activities in smart materials and structures are very important today and represent a significant potential for technological innovation in mechanics and electronics. The growing interest of our society in the problem of sustainable development motivates a broad research effort for optimizing mechanical structures in order to obtain new functional properties such as noise reduction, comfort enhancement, durability, decreased ecologic impact, etc. In order to realize such a multi-objective design, new methods are now available which allow active transducers and their driving electronics to be directly integrated into otherwise passive structures. The number of potential applications of these approaches is growing in many industrial fields such as civil engineering, aerospace, aeronautics, ground transportation, etc. The main research challenge today deals with the development of new multi-functional structures integrating electro-mechanical systems in order to optimize their intrinsic mechanical behavior to achieve desired goals.

In the past few years, a technological revolution has occurred in the fields of integrated Micro Electro Mechanical Systems that offers new opportunities for smart structures design and optimization. We know today that the mechanical integration of active smart materials, electronics, chip sets and power supply systems is possible for the next generation of smart “composite” structures. By using such an integrated active or hybrid distributed set of electromechanical transducers, one can attain new desired vibroacoustic functionalities. In this sense, one can speak of “integrated distributed smart structures”.

RESULTS

The main idea presented is to work with a periodic distribution of shunted piezo transducers integrated on a passive supporting structure (figure 1). A beam structure is the first application but generalization to plates is also presented.

An optimization process is implemented for the design of the electronic shunt circuits so as to achieve a desired dynamical impedance of the passive/active composite beam or plate structure for wave absorption or reflection. The results indicate great potential of such a technique by increased robustness and efficiency of the strategy. Finally, the experimental tests (figure 2) show the real potential of such new approach for structural stabilization or isolation.

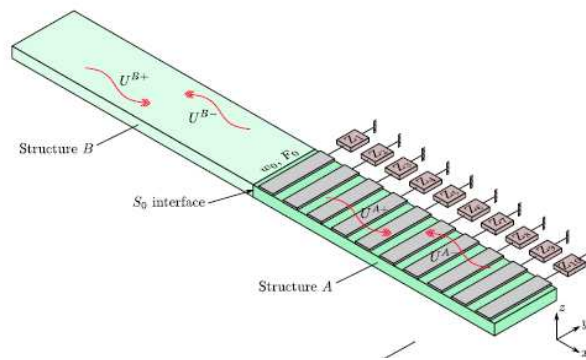


Fig. 1 Concept Overview.

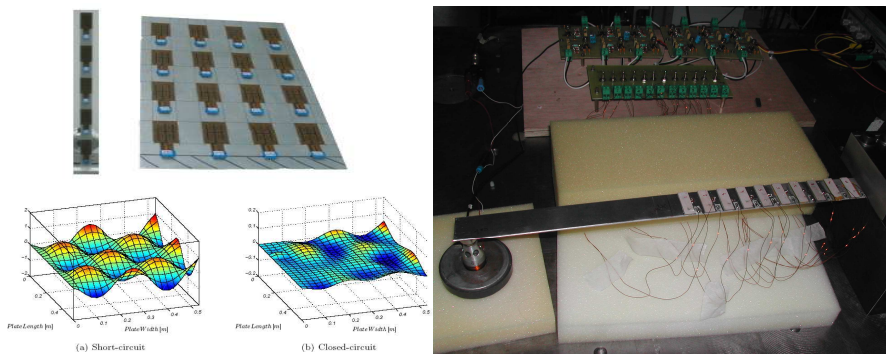


Fig. 2 Experimental set-up and results.

The paper also considers energy balance assessments, absolute efficiency and robustness. It also constitutes a first step in designing new hybrid integrated composite for vibroacoustic optimization.

CONCLUSIONS

The proposed methodology and prototypes demonstrates potentiality and efficiency of such new smart integrated meta-composite material for controlling vibroacoustic flow. It opens the way of a new class of composite materials incorporating smart materials and electronics and achieving a new trend of acoustic functionality without any external power supply or additional mass. Applications for aeronautic and high tech structures represent the next stage of this research program.

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