A homogenized model for dynamic analysis and vibration control of piezoactuated rotationally periodic structures

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Rotationally periodic structures are commonly employed in many technological applications, e.g. satellite antennae, rotors and turbine bladed-disks. The periodic arrangement of identical substructures implies that, for any eigenmode, all the substructures exhibit the same vibration amplitude with different phases. This feature can be exploited in the dynamic analysis, enabling significant simplifications (Shen, 1994). An important issue concerning rotationally periodic structures is to control their vibrations. Some traditional typologies of passive damping devices have been proposed, essentially obtained by adding frictional dampers and viscoelastic damping treatments at the local substructure level. More recently, Wang et al. (1999) proposed to employ piezoelectric actuators, which turn out to be very suitable when size and weight constraints on the controlled structure prevent from the use of the traditional actuators.

In this paper, a broadband vibration control for rotationally periodic structures, composed of many piezoactuated beams clamped to a ring basement, is investigated. It is obtained by connecting the piezoelectric actuators to purely passive periodic electric networks (Bisegna et al., 2005). A homogenization technique is employed to derive a simple analytical model of the electromechanical coupled structure, useful both for the dynamical analysis and for the design and simulation of the passive vibration control scheme. The simulation results show that the proposed passive control technique is effective for the multimodal vibration damping of rotationally periodic structures.

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Curriculum vitae: Giovanni Caruso is graduated in Mechanical Engineering and Mathematics. He got a doctoral degree in Structural Mechanics in 2000. Presently, he is researcher at ITC-CNR. His main research interests are: modelling and vibration control of piezoactuated structures; biomathematics.