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TOPOLOGY OPTIMIZATION FOR COMPLIANCE MINIMIZATION AND ACTUATOR LAYOUT TO VIBRATION SUPPRESS

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Abstract: This article addresses the compliance problem along with the piezoelectric actuator design for active vibration control. The structure layout is obtained by solving a compliance minimization problem while the actuators topology is found by the maximization of a controllability index written in terms of the controllability Gramian, which is a measure that describes the ability of the actuators input to move the system state from an initial condition to a desired final state, at rest for instance, in a finite time interval. Also, the polarization direction of each actuator is defined according to the distribution of an additional design variable. Therefore, it is possible to produce both tensile and compressive fields in different points of the structure using the same applied control voltage. In order to achieve this goal, a material interpolation scheme based on the Piezoelectric Material with Penalization and Polarization (PEMAP-P) model is employed and both the optimum structure/actuator layout and polarization profile are obtained simultaneously. The sensitivities with respect to the polarization and design variables are calculated analytically. Numerical examples are presented considering the control of bending vibration modes for a cantilever beam and a simply supported beam in order to show the efficiency of the proposed formulation. The control performance of the designed structures are analyzed by means of a Linear-Quadratic Regulator (LQR) simulation and these results are compared to the ones obtained by a formulation that does not take into account the actuator polarity in the optimization problem, i.e., the polarization profile is stated a priori.