Optimal piezoelectric resistive–inductive shunt damping of plates with residual mode correction - DTU Orbit (21/07/2019)

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This work concerns vibration suppression of plates and plate-like structures by resonant piezoelectric damping, introduced by resistive–inductive shunts. The performance of this type of shunt damping relies on the precise calibration of the shunt frequency, where an important aspect is the ability to account for the energy spill-over from the non-resonant modes, not taken into account by most available calibration methods. A newly proposed calibration procedure includes this residual mode contribution by a quasi-dynamic modal correction, taking both flexibility and inertia effects of the non-resonant modes into account. In this work, this procedure is implemented in a finite element model combining Kirchhoff plate bending kinematics for the host structure and a plane stress assumption for a pair of bonded piezoceramic patches. The established model is verified by comparison with shunt calibrations from benchmark examples in the literature. As demonstrated by frequency response plots and the obtained damping ratios, the resistive–inductive shunt tuning is influenced by the effect of the non-resonant modes and omission may yield a significant detuning of the shunt circuit. Finally, an alternative method for precise evaluation of the effective (or generalized) electromechanical coupling coefficient is derived from the modal electromechanical equations of motion. This results in a new shunt tuning method, based on the effective electromechanical coupling coefficient obtained by the short- and open-circuit frequencies of the coupled piezoplate structure.

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