Vibration control of smart composite plates using shunted piezoelectric elements

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ABSTRACT

Smart structures, in general, have the ability to respond and reduce vibrations which are caused by external forces. The self-monitoring capability of smart structures is due to the properties of the involved materials, such as piezoelectric sensors or actuators. Passive damping of vibrations using shunted piezoelectric elements is quite common for structures such as beams [1], plates [2], smart panels [3], etc. In fact, shunted piezoelectric circuits can consume the kinetic energy of the controlled system by transferring it to a suitably defined electric impedance. The present investigation focuses on the control of the oscillations of a smart composite plate equipped with shunted piezoelectric transducers. Namely, resonant shunt circuits, i.e. circuits with a resistor and an inductor, which can deteriorate the vibrations near the resonant frequencies, are considered. The structural model of the plate is discretized by using the finite element method yielding to a smart laminate model with elastic and piezoelectric layers. The parameters of the shunted piezoelectric circuit are selected taking into account the first, critical, eigen-modes of the structure. A fine-tuning of the parameters of the electric elements is performed using nature-inspired optimization methods, such as genetic algorithms and particle swarm optimization. The numerical results are compared with other known models in order to prove the efficiency of the proposed method.

Keywords: Vibrations, Smart structures, Piezoelectrics, Shunt circuits

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