Resonant piezoelectric shunt tuning based on the electric current and voltage response to white noise excitation

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ABSTRACT

A tuning procedure for resonant piezoelectric shunt damping based on measurable experimental data is proposed. The procedure is derived from a proposed resonant shunt tuning method designed for the implementation in commercial finite element software, including the contribution from non-resonant vibration modes. It has been found that this procedure is robust and effective for vibration mitigation in both beam and plate structures. The present procedure imposes a random white noise excitation signal to an electromechanical test specimen, while the piezoelectric electrodes are respectively in short- or open circuit conditions. In these two individual conditions a time series is attained by subsequently measuring respectively the electric current and voltage with a high quality multimeter. A Fast-Fourier-Transform is used on these time-series to determine the relative electric current and voltage frequency amplitudes. Finally, the optimum resonant shunt inductances and resistances are determined from the corresponding modal properties, which are extracted from the two frequency response spectra. The method is demonstrated for a free beam with two pairs of piezoceramic patches, one pair for vibration excitation and the other for vibration mitigation. The experimental results agree well with numerical results attained by the commercial finite element software ANSYS®.