An edge-based smoothed finite element method for the active vibration control of piezoelectric structures

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Abstract

The piezoelectric effect plays an important role in the fields of crystal physics and transducer technology. In this work, an edge-based smoothed finite element method (ES-FEM), which has shown great efficiency in solving solid mechanics problems and was supposed to significantly improve the accuracy and convergence rate of the standard finite element method for static, free and forced vibration, is presented to model the response of laminated composite plates with distributed piezoelectric actuators and sensors. The finite element formulation of electro-mechanical coupling dynamic system are derived based on the variational principle with respect to the displacement and electrical potential energy fields, while the mechanics strain and electric fields are smoothed over the smoothing domains associated with the edges of the elements. The charge/current generated by the sensor and the response of the structure to an actuator voltage was calculated independently and then coupled with the feedback control algorithm to actively control the transient response of the plate in a closed loop. Numerical results compared with published experimental and numerical results illustrate the accuracy and capability of ES-FEM for solving electro-mechanical coupling problems.

Keywords: ES-FEM, Piezoelectric structures, Electro-mechanical coupling, Active vibration control.