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Nonlinear vibrations of a sandwich piezo-beam system under piezoelectric actuation

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Abstract: In this paper the problem of nonlinear vibrations of an actuated sandwich slender piezo-system is discussed. The considered system is composed of a host beam with piezoelectric patches bonded to its top and bottom surface, respectively. The host beam ends are supported to prevent longitudinal displacements. By introduction a constant and uniform electric field to each piezo element, an axial compressive or tensile piezoelectric force is induced. Once opposing directions of the electric field vector for both piezo patches, one of the piezo element is compressed, whereas the second one is under tension, what results in the system's bending. The main objective of performed studies is to analyse how different ways of piezoelectric actuation affect the system deflection, which, as a result, modifies its natural nonlinear frequency. The priority parameters are the beam and piezo elements thicknesses, the level of piezoelectric forces actuation, the pattern of forces induction. The problem is formulated on the basis of Hamilton's principle and solved with the use of a perturbation method. During the first sequence of performed calculations, the geometry of the system modified by the electric field is considered. After determination of the structure configuration, the dynamic system response is examined to find its characteristic features. It is proved that the system deflection and its nonlinear frequency depends strongly on the way of the piezoelectric forces induction. Moreover, it is shown that both the static and dynamic responses are very sensitive to any changes in physical or geometrical properties of the structure.