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Stability and vibration of a two-member cantilever column with an integrated PZT rod

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Abstract: This paper concerns the problem of transversal vibration a geometrically non-linear two-member column with a piezoceramic rod being a component of the structure. In the considered system, the external load applied to the column with an unintentional eccentricity and the internal piezo force are distributed among both members. The piezo rod is mounted discretely with an offset distance in regard to the host column what makes that the piezoelectric actuation may be effective in suppressing of prebuckling deflection in the whole range of the external load. Although the main role of the piezoelectric force generated by the actuator is the control of the column shape, it affects also the natural vibration frequency of the system. To analyze the problem a non-linear analytical model of the structure is developed on the basis of Hamilton's principle and solved with use of the perturbation method. Performing adequate computations, the static deflection and internal axial force distribution modified by the electric field application are determined by changing column properties such as the offset distance and the eccentricity of the external load. In the dynamic analysis, the fundamental vibration frequency of the deflected column and the adequate modes are studied in relation to both the external load and the piezoelectric force. It has been proved that the natural vibration frequency, affected by the piezoelectric force, also depends on the matched column and rod materials, the ratio of the cross section of the rod to the host column and the direction of the electric field.

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