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Electrostatically actuated initially curved micro beams: analytical and finite element modelling

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Abstract: Nowadays, industrial production microelectromechanical systems (MEMS) is developing rapidly, so they are widely used in various spheres of human activity: medicine, energy, various systems navigation in the automotive and petroleum industries, etc. Regardless of the purpose of the MEMS, sensitive elements commonly undergo an initial curvature imperfection, due to the microfabrication process. Initial curvature imperfection significantly affects the mechanical behavior of microplates, beams, etc. For example, initially curved microbeams loaded by concentrated forces may exhibit bistability (the existence of two different stable equilibria under the same loading). The transition between two stable states in these structures is commonly referred to as a snap-through buckling. The basic sensitive elements were chosen for the analysis: a nonlinearly elastic string in a geometrically exact framework, initially curved beam. Equilibria forms branching for various configurations of electric field and initial curvature was investigated utilizing model order reduction technique (MOR) and numerical continuation methods. In addition to the bifurcation diagrams, natural frequencies of the above mentioned structures were also considered, and their dependency on the magnitude of the electric field and the other parameters of the system was analyzed. Finite element modeling of the above mentioned problems of electroelasticity was carried out in the ANSYS software system and conclusions were drawn on the degree of applicability of FEM and ROM-FEM methods under various conditions.

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