The symmetric and asymmetric buckling of curved micro beams subjected to distributed electrostatic force is studied. The analysis is carried out for two separate cases: a case of a stress-free beam which is initially curved by fabrication [1], and a case of a pre-stressed buckled beam for which the curvature is due to an axial force. The analysis is based on a reduced order model resulting from the Galerkin decomposition with vibrational or buckling modes of a straight beam used as base functions. Including the two first symmetric and asymmetric modes, the location of the symmetric buckling limit points as well as the location of the points at which the asymmetric response bifurcates from the symmetric one are obtained. An example of the dependence of these locations on the compressive axial load applied to an initially straight beam prior to the application of the electrostatic force is shown in Fig.1.
On the basis of this information, the criteria of the symmetric limit point buckling and of the non-symmetric bifurcation are derived in terms of the beams geometric parameters (or the pre-stressing). While the necessary symmetry breaking criterion establishes the conditions for the appearance of bifurcation points on the unstable branch of the symmetric limit point buckling curve, the sufficient criterion assures a realistic asymmetric buckling bifurcating from the stable branches of the symmetric equilibrium path. It is shown that while the symmetry breaking conditions are affected by the nonlinearity of the electrostatic force, its influence is less pronounced than in the case of the symmetric snap-through. A comparison between the results provided by the RO model, and those obtained by direct numerical analyses confirms the accuracy of the symmetry breaking criteria and their applicability for the analysis and design of micro beams.

References: