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Snap-through phenomena during rotation of a clamped elastic rod

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The key to the design of soft structures lies in the development and use of nonlinear mechanical models, among which, the Euler's elastica allows the description of large deflection of elastic rods and explains serpentine movement, tentacle or a trunk manipulation of objects [1]. A basic problem of soft robot arm [2,3,4,5] is addressed in the presentation through new theoretical, numerical, and experimental developments.

We consider the large deflection of a cantilever beam, with its free end subject to a dead load, in the case when the clamp is subject to a continuous rotation. When the load is lower than the buckling value of the rod in its straight configuration, the system behaves as an "elastica compass", so that smooth transitions of the deformed shape are observed and the free end traces a closed curve, which approaches a circle as the stiffness of the road is increased. When the load is higher than that corresponding to buckling of the straight configuration, the system reaches an unstable configuration, for which the rod suffers a snap through instability and dynamically approaches another unadjacent. In thic case, the elastic rod behaved as an "elastica catapult".

An analytical model, based on the elastica, is developed to predict the critical angle for which the snap through occurs, while the subsequent dynamic motion is simulated through the definition of a specific numerical procedure. A specifically designed experimental setup is realised to investigate the structural system and to validate the reliability of the theoretical results.

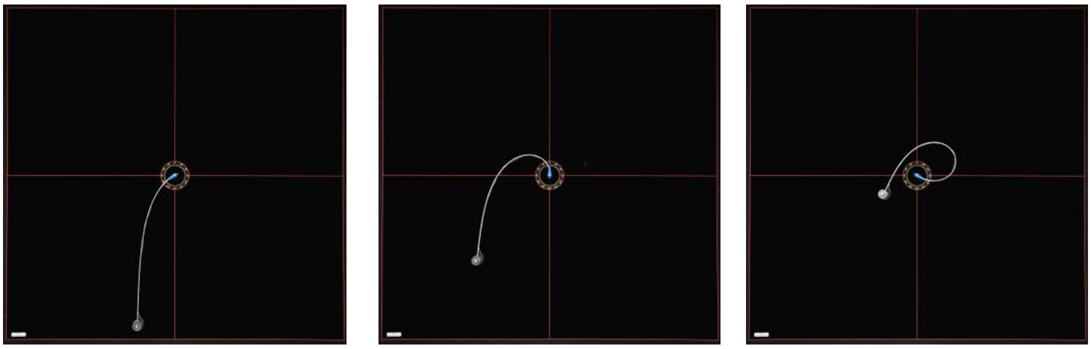

Fig. 1: The setup as the experimental realization of the considered structural system

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