Necking and bifurcations of thin-walled cylinders and coated elastic disks

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Necking localization under uniaxial tension is experimentally observed for a ductile thin-walled cylindrical tube, made up of soft polypropylene. Necking nucleates in multiple locations of the tube and spreads throughout it, involving also the occurrence of higher-order modes, evidencing trefoil and fourth-foiled shaped cross sections. No evidence in other ductile materials of such a complicated necking occurrence and growth were found for thin-walled cylinders. With the aim of theoretically modelling this phenomenon, as well as all other possible bifurcations, a two-dimensional formulation is introduced, in which only the mean surface of the tube is considered, paralleling the celebrated Flügge's treatment of cylindrical shells, subject to axial compression. That treatment is is extended to include tension and a broad class of nonlinear-hyperelastic constitutive law for the material, which is also assumed to be incompressible. This bifurcation problem is complemented with the akin bifurcation analysis of an elastic disk coated with a Cosserat isoperimetric constraint [1]. The latter is treated as an elastic circular rod, either perfectly or partially bonded (with a slip interface in the latter case) and is subjected to three different types of uniformly distributed radial loads (including hydrostatic pressure). The proposed solution technique employs complex potentials to treat the disc's interior and incremental Lagrangian equations to describe the prestressed elastic rod modelling the coating. The presented results find applications in various fields, ranging from aerospace and automotive engineering to the vascular mechanobiology and morphogenesis of plants and fruits.

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References

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