LATERAL BUCKLING OF A HYPERLEASTIC SOLID UNDER FINITE BENDING

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The problem of a beam that laterally buckles when subjected to flexure in the plane of greatest bending stiffness has been investigated first in the pioneering works by Prandtl and Michell in 1899. Those studies, and many others appeared in Literature afterwards, are based on the classical beam theory, which predicts that the cross sections experience a rigid rotation maintaining their original shape after deformation.
However, experimental investigations highlight that a more challenging scenario takes place when, instead of beam-like solids, plate-like bodies are bent in their stiffest plane. In such a situation, an elastic deformation takes place also in the planes of the cross sections (Figure 1). This holds true particularly if large bending is needed to reach the onset of flexural–torsional buckling.

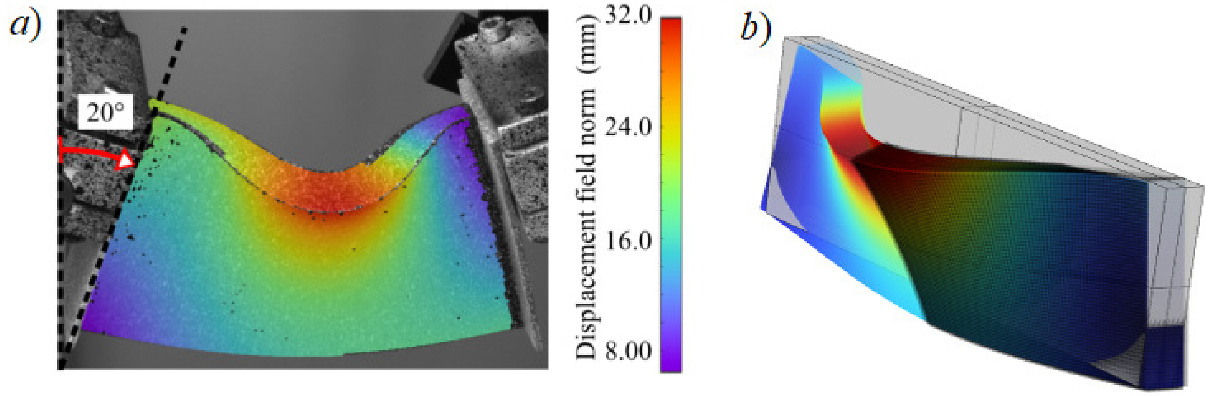

Figure 1. Bending of a plate-like body: (*a*) Pure bending test and (*b*) FE simulation of a 10x80x200 mm^3 prism made of neoprene rubber.

The present works addresses the problem of the lateral buckling of a hyperelastic prismatic body under finite bending accounting for the deformation of the cross sections also. The stored energy function for compressible Mooney-Rivlin materials is considered, accounting for the material and geometric nonlinearities. The problem is handled through the energy method. Starting from the bent configuration of the prism, an out-of-plane displacement field is superposed as a small perturbation. Then, the vanishing of the variation of the total potential energy allows assessing the critical angle (or, equivalently, the critical bending moment) for which a deflected equilibrium configuration adjacent to the purely bent one becomes possible. According to the energetic approach, the method provides upper bounds of the critical loads. However, it is shown that the accuracy of the solution may be conveniently improved by enriching the general expression of the perturbation.