
Dynamical elastic boundary layer in a snapping problem

Gregory Kozyreff^{*1}, Hadrien Bense², Lucie Domino^{3,4}, and Basile Radisson⁵

¹Université libre de Bruxelles – Belgium

²Laboratoire d'Acoustique de l'Université du Mans – Université du Mans – France

³Institut universitaire des systèmes thermiques industriels – CNRS – France

⁴laboratoire IUSTI – Aix Marseille Université (Aix-en-Provence) – France

⁵Institut Jean Le Rond d'Alembert – APHP, Pitié-Salpêtrière university hospital, Sorbonne Université UPMC Paris VI – France

Abstract

We study the snap-through of a buckled beam triggered by the rotation of one of its end. A quasistatic actuation leads to a saddle-node bifurcation at a known critical angle which depends only on the compression. Dynamics, however, changes this picture. Experiments indicate that the more rapidly one actuates the end of an elastic beam, the lower the critical angle at which it can snap from a high-order stable buckling mode to the fundamental one. We consider here actuation times that are much smaller than the fundamental natural oscillation period of the beam and present an asymptotic analysis of the transient leading to snapping in that limit. We find that the perturbation induced at one end of the beam invades the rest of the body through an expanding boundary layer. This boundary layer is inherently dynamical and not due to the smallness of the bending stiffness of the beam. During the transient, highly dispersive self-similar waves are identified in the boundary layer. As these waves escape the boundary layer and enter the core of the beam, their oscillations progressively match the natural frequencies of the beam.

^{*}Speaker