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MECHANICAL RESPONSE OF ELASTIC OPEN-CELL FOAMS UNDER PUNCHING. INSIGHTS FROM EXPERIMENTS AND SIMULATIONS.

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Elastic polyether-polyurethane (EPP) foams are lightweight cellular solids used in packaging, sports equipment, sandwich panels, upholstered furniture and other applications in which they are typically subjected to punching and called upon to absorb energy and limit peak stresses. We carry out experiments with two types of punch, wedge-shaped and conical, and two types of foam specimen, tall and short. The force-penetration curves display some striking features. For the wedge-shaped punch, the curves remain *linear* up to a penetration of at least 40% of the height of the specimens. For the conical punch, the curves remain *quadratic* up to a comparably large penetration. In either case, a nearly discontinuous change in stiffness supervenes when the penetration reaches about 40% of the height of the specimens: for the tall specimens, the stiffness drops and the force-penetration curves become momentarily almost flat; for the short specimens, the stiffness shoots up and the force-penetration curves enter a stage of accelerating hardening. To explain these experimental results, we formulate a theoretical model in which a foam can undergo a configurational phase transition under compression, and carry out finite-element simulations using a micromechanical constitutive relation of EPP foams[1]. The finite-element results are in good accord with the experimental results, and they allow us to verify some of the assumptions on which the theoretical model is predicated.

References

[1] T. Sabuwala and G. Gioia. Skeleton-and-bubble model of polyether-polyurethane elastic open-cell foams for finite element analysis at large deformations. *Journal of the Mechanics and Physics of Solids*, Vol. **61**, 886–911, 2012.