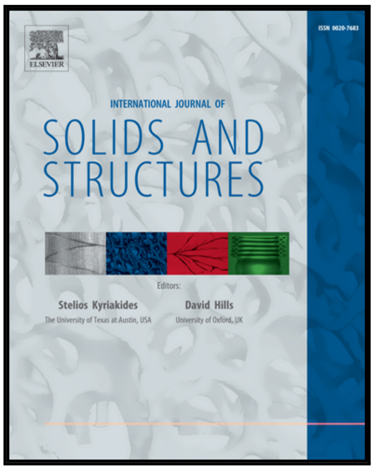

Swelling, Inflation, and a Swelling-Burst Instability in Hyperelastic Spherical Shells

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Swelling, Inflation, and a Swelling-Burst Instability in Hyperelastic Spherical Shells

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Abstract

The incompressible hyperelastic Mooney-Rivlin constitutive model allows for pressure-inflation response of spherical shells that could either be globally stable (a monotonic pressure-radius graph) or could instead involve instability jumps of various kinds as pressurization proceeds. The latter occurs when the pressure-radius graph is not monotonic, allowing for a snap-through bifurcation that gives a sudden burst of inflation. For a given structure (shell thickness) composed of a specific material (a parameter choice in the M-R constitutive model), the form of the pressure-radius graph becomes fixed, enabling the determination of whether and when such a burst will be triggered. Internal swelling of the material that makes up the shell wall will generally change the response. Not only does it alter the quantitative pressure-inflation relation but it can also change the qualitative stability response, allowing burst phenomena for certain ranges of swelling and preventing burst phenomena for other ranges of swelling. This paper provides a systematic framework for predicting how such swelling ranges depend on structural geometry and material parameters.

Keywords: hyperelasticity, swelling, shells, burst

1. Introduction

Soft matter swells, causing quantitative changes in the material's mechanical properties. These can lead to qualitative changes in the stability of the overall structure, possibly triggering various bifurcation phenomena associated with localization, buckling and other forms

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