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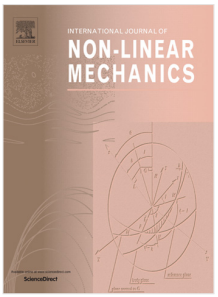

Axial and circumferential buckling of a hyperelastic tube under restricted compression

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Axial and circumferential buckling of a hyperelastic tube under restricted compression

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Abstract

Axial compression of a rubber tube where the movement of the outer surface is restricted is an important procedure used to seal a packer. Instabilities may cause the seal to fail. In this paper, we study the bifurcations of a hyperelastic tube under restricted compression and consider both axial and circumferential modes. Bifurcation condition is numerically determined and it is found that the critical stretch is a decreasing function of the ratio of inner and outer radii A/B. Furthermore, the critical mode number is always finite for both modes. In particular, a transition between axial and circumferential modes occurs when A/B passes through a critical value of 0.6716. A WKB analysis is carried out to provide an asymptotic expression for the axial stretch λ_z when the mode number n is large. Finally an application of our results in sealing devices is discussed.

Keywords: tube, bifurcation, finite deformation, mode transition, sealing device

1. Introduction

Seals play an important role in modern engineering applications. In particular, a packer used to seal the gap between the oil and base pipes is quite crucial in oil and gas industry. Lundberg (1896) invented the most widely used traditional packer composed of a rubber tube. Since then various embodiments of seals are created and one of an outstanding example is the swelling packer presented by Laflin and Durborow (1979). This paper mainly focuses on the deformation when sealing a traditional packer. We first briefly introduce the main procedures taking seals in oil industry as a example. Three parts including the oil pipe, packer and base pipe are involved during a seal (Clegg, 2007). Initially, the inner

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