20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

A deviatoric strain energy function for inflated elastic membranes

Stefano Sirotti[1], Matteo Pelliciari[2], Angelo Marcello Tarantino[3]

[1] Engineering Department "Enzo Ferrari", University of Modena and Reggio Emilia, Italy.
stefano.sirotti@unimore.it
[2] Engineering Department "Enzo Ferrari", University of Modena and Reggio Emilia, Italy.
matteo.pelliciari@unimore.it
[3] Engineering Department "Enzo Ferrari", University of Modena and Reggio Emilia, Italy.
angelomarcello.tarantino@unimore.it

Paper ID: 83
Symposium S1: Mechanical behavior of polymers and biopolymers: theory, simulations and testing
Extended Abstract

Abstract

Inflated elastic membranes exhibit complex mechanical and kinematic responses that are not fully captured by existing constitutive models. In this work, we introduce a deviatoric strain energy function (SEF) specifically formulated to address this limitation. The model parameters are identified through bulge-test experiments conducted on two elastomers, providing pressure–deflection data together with measurements of transversal and radial stretches at the membrane pole. These observations enable a comprehensive validation, showing that the proposed SEF reproduces the inflation behaviour of circular membranes more accurately than current models. The formulation features a simple polynomial structure, offers a clear physical interpretation of the influence of each term on the pressure response, and includes a well-defined fitting strategy. A complete constitutive model for inflated membranes is obtained when coupling the proposed SEF with a volumetric part previously developed by the authors. This work provides both novel experimental insights and theoretical improvements to the mechanics of inflated membranes and serves as foundation for the study of more complex problems.

Keywords:

Hyperelasticity Bulge tests Softening Nonlinear fitting Compressibility