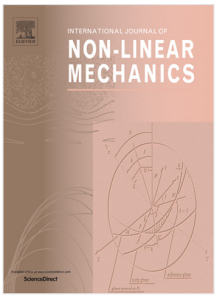
Accepted Manuscript



Stress-free bending of a neo-Hookean plate induced by growth: Exact solution and experiments

Jiong Wang, Qiongyu Wang, Hui-Hui Dai

PII: S0020-7462(18)30037-4
DOI: https://doi.org/10.1016/j.ijnonlinmec.2018.05.017
Reference: NLM 3025

To appear in: *International Journal of Non-Linear Mechanics*

Received date : 16 January 2018
Revised date : 22 May 2018
Accepted date : 23 May 2018

Please cite this article as: J. Wang, Q. Wang, H.-H. Dai, Stress-free bending of a neo-Hookean plate induced by growth: Exact solution and experiments, *International Journal of Non-Linear Mechanics* (2018), https://doi.org/10.1016/j.ijnonlinmec.2018.05.017

Stress-free bending of a neo-Hookean plate induced by growth: exact solution and experiments

Jiong Wang[a], Qiongyu Wang[a], Hui-Hui Dai[b,*]

[a]*School of Civil Engineering and Transportation, South China University of Technology, 510640 Guangzhou, Guangdong, China*
[b]*Department of Mathematics, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon Tong, Hong Kong*

Abstract

We study the growth-induced large deformations of a thin hyperelastic plate through both theoretical analyses and experimental tests. In particular, we investigate the stress-free states of the plate during the growth process systematically. First, for the biaxial growth case and with the assumption of plane-strain deformation, we formulate the governing PDE system of the plate model, where the traction-free boundary conditions are adopted. By considering the stress-free states of the plate, a constraint condition on the growth functions can be derived. Then, by choosing some specified growth functions, we obtain the exact solution to the governing system, which represents the stress-free bending deformation of the plate. With the obtained solution, the effects of the different growth parameters on the current configuration of the plate can be revealed. To show the prediction power of the exact solution, we conduct some experiments on the swellings of thin hydrogel samples in water. It is found that the deformation styles of the hydrogel samples are consistent with those described by the exact solution. The analytical results obtained in this paper is helpful for understanding the mechanical behaviors of hyperelastic plates in free growth, which would also be useful for the design of soft devices. Besides that, the problem considered in this paper can serve as a benchmark example for testing the correctness

*Corresponding author. Tel.: +852 34428660; fax: +852 34420250.
Email addresses: ctjwang@scut.edu.cn (Jiong Wang), 201620105278@mail.scut.edu.cn (Qiongyu Wang), mahhdai@cityu.edu.hk (Hui-Hui Dai)