Waves in pre-stressed immersed plates and tubes: Application to ultrasound elastography of thin-walled soft materials

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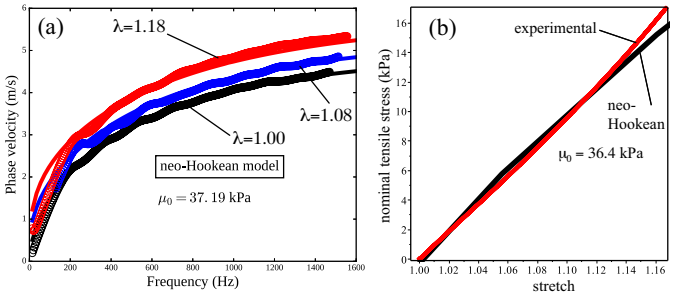
Abstract

It is a great challenge to be able to measure the *in vivo* mechanical properties of thin-walled biological soft tissues such as mitral valve, artery and bladder. Here we investigate the properties of guided waves in immersed pre-stressed plates and tubes, and show that they can address this challenge. To this end, we carry out both (i) a theoretical analysis based on incremental wave motion in finite deformation theory and (ii) finite element simulations. Our analysis leads to a novel method based on the ultrasound elastography to image the elastic properties of pre-stressed thin-walled soft tissues and artificial soft materials in a non-destructive and non-invasive manner. To validate the theoretical and numerical solutions and demonstrate the usefulness of the corresponding method in practical measurements, we perform (iii) experiments on polyvinyl alcohol cryogel phantoms immersed in water.



(a) Curve-fitting of dispersion curves to experimental data for guided waves in a plate in plane strain with 0%, 8% and 18% stretch.

(b) Uni-axial (destructive) testing.

References

[1] G.-Y. Li, Q. He, R. Mangan, G. Xu, C. Mo, J. Luo, M. Destrade, Y. Cao, Guided waves in pre-stressed hyperelastic plates and tubes: Application to the ultrasound elastography of thin-walled soft materials, *Journal of the Mechanics and Physics of Solids*, in press, 2017. DOI: j.jmps.2017.02.008