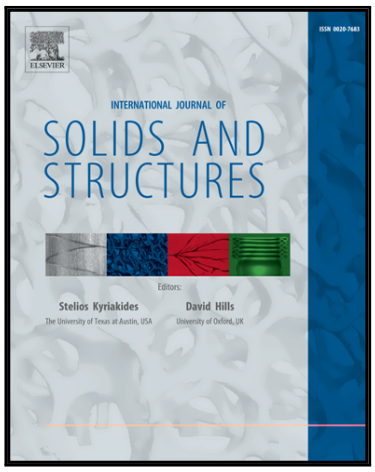

Thin-wall composite sphere in finite shear deformation

Gidon Weil, Gal deBotton

PII: S0020-7683(17)30217-2
DOI: 10.1016/j.ijsolstr.2017.05.014
Reference: SAS 9576

To appear in: *International Journal of Solids and Structures*

Received date: 27 December 2016
Revised date: 29 April 2017
Accepted date: 10 May 2017

Please cite this article as: Gidon Weil, Gal deBotton, Thin-wall composite sphere in finite shear deformation, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.05.014

Thin-wall composite sphere in finite shear deformation

Gidon Weil[†] and Gal deBotton[†,‡,1]

[†]*Dept. of Mechanical Engineering, Ben-Gurion University, Beer-Sheva 84105, Israel*

[‡]*Dept. of Biomedical Engineering, Ben-Gurion University, Beer-Sheva 84105, Israel*

May 11, 2017

Abstract

We examine the mechanical response of an incompressible thin-wall composite sphere (TWCS) within the framework of finite deformation elasticity. Specifically, we consider TWCSs with a neo-Hookean core phase and a stiffer or a softer shell subjected to simple shear displacement and traction boundary conditions. We derive the general forms of the displacement and the pressure fields in both phases in terms of a power series about the shear magnitude. The predictions of the analytical solutions are analyzed and compared with corresponding results of finite element simulations. In order to examine the range of the validity of the thin shell assumption we model TWCSs with shell volume fractions of 5 and 10%.

We find that a relatively small number of terms in the series is required for a good agreement with the numerical simulations in the cases of TWCSs with a stiffer shell under displacement boundary condition and TWCSs with a softer shell under traction boundary conditions. For the dual pair of TWCSs with a softer or stiffer shell under displacement or traction boundary conditions, respectively, the analytical solution is applicable only when the contrast between the phases shear moduli is considerably smaller than the shell volume fraction. Moreover, for each of the above pairs the spatial distributions of the stresses in the core are rather similar. In the shell, however, the stress distributions depend primarily on the contrast between the shear moduli of the two phases. At the macro-level we find that while the stored strain energy is identical in TWCSs subjected to identical magnitudes of shear strain or shear stress under both types of boundary conditions, a Poynting effect is observed in the finitely deforming TWCSs.

1 Introduction

[1]corresponding author: e-mail: debotton.g@icloud.com, tel: int. (972) 8 - 647 7105