Circular Cylindrical Shell Made of Neo-Hookean - Fung Hyperelastic Material Under Static and Dynamic Pressure

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Abstract
The present study is devoted to the investigation of static and dynamic behavior of the three-layered composite shell made of hyperelastic material. Such a shell can be considered as a model of human aorta. Since soft biological materials are essentially nonlinear even in the elasticity zone, not only geometrical, but also physical nonlinearity should be taken into account. The physical nonlinearity of soft biological tissues is usually modeled by certain hyperelastic law. The law chosen for this study is the combination of the Neo-Hookean law, which describes the isotropic response at small strains, and Fung exponential law, that models the stiff anisotropic response of the collagen fibers at larger strains. Each of three shell layers has its own hyperelastic constants set. These constants are determined basing on experiential data [1]. The strain-deflection relations are modeled with higher-order shear deformation theory [2].
Initially, the shell is preloaded with static pressure. Since the defection in our study is large we use the expression for pressure as a follower load [3]. The static problem is solved with the help of the local models method [4]. Afterwards, the free and forced dynamical response of the preloaded shell is studied both in vacuo and with still fluid inside. The modes of interest are the first axisymmetric mode and mode with two half-waves in circumferential direction (so-called collapse mode).
It is found that static pressure decreases the dynamic nonlinearity and it is quite weak. At the same time, the presence of fluid makes the softening nonlinearity stronger as in case of shells of conventional material [5].

Keywords
Hyperelastic material, free and forced dynamical response

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