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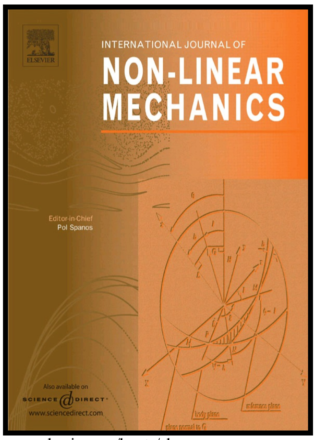

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Understanding the need of the compression branch to characterize hyperelastic materials

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Abstract

Soft biological tissues are frequently modeled as hyperelastic materials. Hyperelastic behavior is typically ensured by the assumption of a stored energy function with a pre-determined shape. This function depends on some material parameters which are obtained through an optimization algorithm in order to fit experimental data from different tests. For example, when obtaining the material parameters of isotropic, incompressible models, only the extension part of a uniaxial test is frequently taken into consideration. In contrast, spline-based models do not require material parameters to exactly fit the experimental data, but need the compression branch of the curve. This is not a disadvantage because as we explain herein, to properly characterize hyperelastic materials, the compression branch of the uniaxial tests (or valid alternative tests) is also needed, in general. Then, unless we know beforehand the tendency of the compression branch, a material model should not be characterized only with tensile tests. For simplicity, here we address isotropic, incompressible materials which use the Valanis-Landel decomposition. However, the concepts are also applicable to compressible isotropic materials and are specially relevant to compressible and incompressible anisotropic materials, because in biomechanics, materials are frequently characterized only by tensile tests.

Keywords: Hyperelasticity; Biological tissues; Experimental determination; Ogden model; Sussman-Bathe model

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