World Academy of Science, Engineering and Technology
International Journal of Mechanical and Mechatronics Engineering
Vol:12, No:07, 2018

Hyperelastic Formulation for Orthotropic Materials

Authors : Daniel O'Shea, Mario M. Attard, David C. Kellermann

Abstract : In this paper, we propose a hyperelastic strain energy function that maps isotopic hyperelastic constitutive laws for the use of orthotropic materials without the use of structural tensors or any kind of fiber vector, or the use of standard invariants. In particular, we focus on neo-Hookean class of models and represent them using an invariant-free formulation. To achieve this, we revise the invariant-free formulation of isotropic hyperelasticity. The formulation uses quadruple contractions between fourth-order tensors, rather than scalar products of scalar invariants. We also propose a new decomposition of the orthotropic Hookean stiffness tensor into two fourth-order Lamé tensors that collapse down to the classic Lamé parameters for isotropic continua. The resulting orthotropic hyperelastic model naturally maintains all of the advanced properties of the isotropic counterparts, and similarly collapse back down to their isotropic form by nothing more than equality of parameters in all directions (isotropy). Comparisons are made with large strain experimental results for transversely isotropic rubber type materials under tension.

Keywords : finite strain, hyperelastic, invariants, orthotropic
Conference Title : ICCM 2018 : International Conference on Computational Mechanics
Conference Location : Prague, Czechia
Conference Dates : July 09-10, 2018