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Finite Eigenstrains in Nonlinear Elastic Solid Wedges

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Abstract : Eigenstrains in nonlinear solids are created due to anelastic effects such as non-uniform temperature distributions, growth, remodeling, and defects. Eigenstrains understanding is indispensable, as they can generate residual stresses and strongly affect the overall response of solids. Here, we study the residual stress and deformation fields of an incompressible isotropic infinite wedge with a circumferentially-symmetric distribution of finite eigenstrains. We construct a material manifold, whose Riemannian metric explicitly depends on the eigenstrain distribution, thereby we turn the problem into a classical nonlinear elasticity problem, where we find an embedding of the Riemannian material manifold into the ambient Euclidean space. In particular, we find exact solutions for the residual stress and deformation fields of a neo-Hookean wedge having a symmetric inclusion with finite radial and circumferential eigenstrains. Moreover, we numerically solve a similar problem when a symmetric Mooney-Rivlin inhomogeneity with finite eigenstrains is placed in a neo-Hookean wedge. Generalization of the eigenstrain problem to other geometries are also discussed.

Keywords : finite eigenstrains, geometric mechanics, inclusion, inhomogeneity, nonlinear elasticity
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