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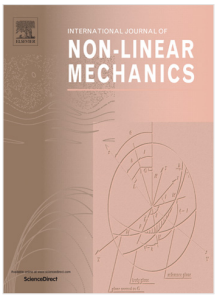

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On Viscoelastic Beams undergoing Cyclic Loading: Determining the Onset of Structural Instabilities

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Abstract

Structures made of viscoelastic materials generate sufficient heat during relatively long exposure to cyclic loading thereby perceptibly altering their body temperature. Temperature changes influence the rate of stress relaxation (or the rate of creep) in viscoelastic materials which in turn affects the deformations of the structures. This study is aimed at understanding the consequences of heat generation due to energy dissipation in viscoelastic materials under cyclic loading and its consequences on the overall time-dependent deformations of structures. A relevant practical application would be understanding cyclic failure (fatigue) in viscoelastic structures. As an example, we consider a simple polymeric beam under bending deformation due to cyclic mechanical loading. A viscoelastic constitutive model for thermorheologically simple materials is used to describe the thermo-mechanical response of the polymeric beam. The amount of energy dissipation that is converted into heat is accounted for in formulating the constitutive model. In beams under bending, the regions with the larger stresses generate more heat, which accelerate the stress relaxation in these regions and cause a temperature gradient in the beam. In the analyses we also allow the generated heat to be conducted. The governing equations are implemented in ABAQUS finite element for coupled heat conduction and deformation analyses. The accelerated stress relaxation (or creep strain) due to an increase in temperature from the energy

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