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Three-dimensional modeling of pseudoelastic effect of the shape memory alloys

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Abstract

The present work aims to develop a 3D constitutive model to describe pseudoelastic effect on the behavior of memory shape alloys. This phenomenological constitutive model is based on a set of variables: temperature and stress as control variables, and the fraction of the martensite as an internal variable. By using the first and the second principle of thermodynamics and with a simple formalism, we have developed constitutive equations followed by criteria of transformations. This developed model has parameters intended to be determined by a tensile pseudoelastic test. We have introduced an algorithm to simulate the response of the model with respect to experimental data. Three cases were considered: one dimensional, biaxial and triaxial loading.

Keywords: constitutive relations, martensite fraction, shape memory alloys, pseudoelastic effect.

1. Introduction

In the last decades, the materials field development has seen an extraordinary progress because of new applications of materials. The shape memory alloys, which belong to a particular group of materials called smart materials, form an interesting part of the entirely new used materials. These materials exhibit a unique behavior in comparison with conventional materials. Researchers, scientists and engineers were attracted by this behavior, so several studies were pursued to understand this behavior and find behavior laws. Consequently, a large number of models have been developed. Because of their properties, these materials are introduced into numerous areas such as biomedical field, car industry, aerospatial applications, aviation field and others (Lagoudas et al. 2004). By using these materials, many alternatives which appear economical and practical were adopted. The use of such materials requires a good description of the constitutive law.