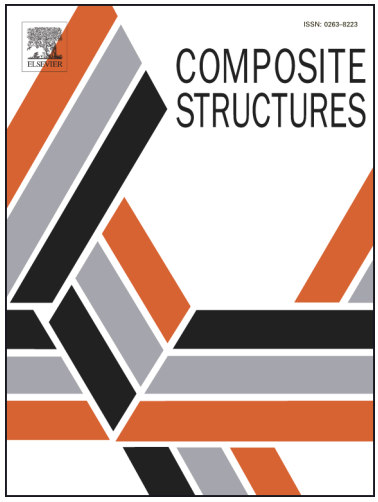

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Multiscale analysis of nonlinear composites via a mixed reduced order formulation

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Abstract

In this paper a new multiscale approach is presented for the analysis of structures made of composite material characterized by elastoplastic or viscoplastic nonlinear response. Scale separation is assumed so that the homogenization theory can be applied: at the structural scale (macroscale) the material appears as homogeneous, while at the microscale it is characterized by a heterogeneous microstructure that affects the global behavior of the structure. The resolution of the micromechanical problem is performed developing a reduced order homogenization technique based on a mixed variational formulation, named Mixed Transformation Field Analysis (MxTFA). The microscopic reduced internal variables are the stress and plastic multiplier parameters of RVE subsets, whose evolution is computed enforcing the weak form of the governing equations for every subset. Some numerical tests are performed to show the accuracy and efficiency of the proposed multiscale technique.

Keywords: Homogenization; Elastic-viscoplastic material; Variational formulation; TFA; Multiscale analysis.

1 Introduction

A composite is a material made out of two or more constituents (phases) combined together in order to achieve desirable mechanical or thermal properties. In the last decades, the use of composite materials has widely increased in many engineering applications. The first use of composites dates back in the 1950s in the aircraft industry: nowadays, aircraft structures are commonly made up of 50-70 percent of composite materials. From the aerospace engineering composites spread to other fields such as

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