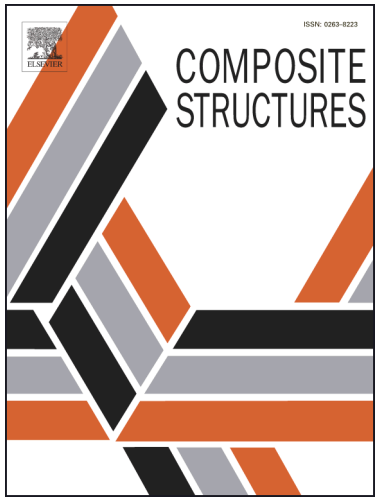

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3D modeling of shape memory alloy fiber reinforced composites by multiscale finite element method

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Abstract

A 3D generic multiscale finite element method (FE^2) is proposed for modeling the pseudo-elasticity and the shape memory effects of shape memory alloy (SMA) fiber reinforced composites. Composites are separated into a macroscopic and a microscopic level, where the constitutive behavior of each integration point on macroscopic level is represented by the effective behavior of a corresponding representative volumic element (RVE). This effective behavior is computed by finite element method under the RVE meshed by volumic element. The real-time information transition between the two levels is realized on a commercial platform ABAQUS via its user defined subroutine (UMAT). A thermodynamic model, proposed by Chemisky et al., [1], is adopted to describe the total constitutive behavior of the SMA. This model considers three path-dependent strain mechanisms related to phase transformation, martensite reorientation and twin accommodation by the derivation of Gibbs free energy. Several thermodynamic tests from the literature subjected to tension-compression and bending loads are studied to validate our multiscale model, which shows good accuracy and reliability. Besides, this model could be used for further design and simulation of SMA applications in a wide range thanks to its generic computing platform ABAQUS.

Keywords: *Shape memory alloys; Composites; Numerical homogenization; Multiscale finite element method.*