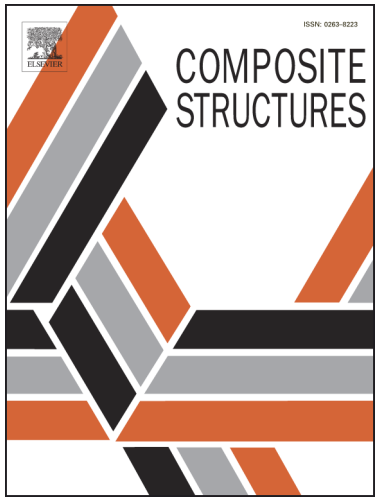

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PII: S0263-8223(15)00497-3
DOI: http://dx.doi.org/10.1016/j.compstruct.2015.06.033
Reference: COST 6532

To appear in: *Composite Structures*

Please cite this article as: Damanpack, A.R., Liao, W.H., Aghdam, M.M., Shakeri, M., Bodaghi, M., Micro-Macro Thermo-Mechanical Analysis of Axisymmetric Shape Memory Alloy Composite Cylinders, *Composite Structures* (2015), doi: http://dx.doi.org/10.1016/j.compstruct.2015.06.033

Micro-Macro Thermo-Mechanical Analysis of Axisymmetric Shape Memory Alloy Composite Cylinders

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Abstract: The present work deals with the micro-macro analysis of shape memory alloy (SMA) fiber-reinforced Epoxy/Aluminum matrix composite cylinders under combined thermo-mechanical loadings. A robust phenomenological constitutive model is implemented to simulate martensite transformation, reorientation of martensite variants, pseudo-elasticity and shape memory effects of SMAs. Epoxy is assumed to behave as a linearly elastic material while Aluminum is considered to behave as an elastic-plastic material with linear kinematic hardening. A representative volume element (RVE) consisting of SMA fibers surrounded with Epoxy/Aluminum matrix is simulated to determine the overall constitutive response of the composite in the generalized plane-strain state. Deformations of the RVE and macro composite cylinder are described based on the small strain and large displacement regimes. Finite element solutions coupled with an iterative elastic-predictor inelastic-corrector procedure are developed to analyze the RVE and macro composite cylinder. In particular, the micro-mechanical solution is implemented to evaluate the constitutive behavior of structural elements made of SMA composite at each iteration of each load step. Parametric studies are performed to examine the effects of pre-strain, SMA fiber volume fraction, fiber orientation, stacking sequence and loading order on the macro-thermo-mechanical responses of long composite cylinders subjected to internal pressure, axial, torsional and thermal loadings.

Keywords: Micro-macro analysis; Composite cylinders; Shape memory fibers; Martensitic transformation; Reorientation of martensite; Finite element solution.

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