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Multiscale technique for nonlinear analysis of elastoplastic and viscoplastic composites

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Abstract

Aim of the present paper is to develop an efficient multiscale procedure for studying the mechanical response of structural elements made of elastoplastic or viscoplastic composite materials. The micro and the macro scales are considered separated. At the microscale a PieceWise Uniform Transformation Field Analysis (PWUTFA) homogenization technique is adopted to derive the overall response of a periodic composite. Thus, a Unit Cell (UC) containing all the properties of the heterogeneous material is analyzed and divided in subsets; in each one the inelastic strain is considered uniform, i.e. constant, and represents the history variable of the analysis. Elastoplastic and elasto-viscoplastic models with isotropic hardening are adopted in order to describe the nonlinear response of the constituents. A new numerical procedure is developed in order to solve the evolutive problem in all the subsets simultaneously adopting a predictor-corrector technique. The corrector phase is solved by means of a modified Newton-Raphson iterative procedure. Furthermore, the tangent consistent with the algorithm is computed and adopted in the multiscale computations. Numerical applications are carried out in order to assess the efficiency of the proposed multiscale approach.

Keywords: Composites, Multiscale analysis, Homogenization, TFA, Plasticity, Viscoplasticity.

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