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NUMERICAL ALGORITHMS FOR PLASTICITY MODELS WITH NONLINEAR KINEMATIC HARDENING

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Computational modeling of rate independent plasticity has nowadays achieved significant improvements, both in the proper formulation of the theoretical laws governing the inelastic behavior and in the definition of the numerical procedures for the integration of the boundary value problem, see among others Simo and Hughes [1], Zienkiewicz Taylor and Fox [2] and Taylor [3]. In the numerical integration of rate independent plasticity problems the assumption of a linear kinematic hardening behavior is often adopted. This assumption proves to be advantageous from the numerical point of view since it often provides numerical algorithms characterized by computational efficiency and a symmetric tangential stiffness matrix. Nevertheless, in the last decades in the literature it has been outlined the necessity of adopting nonlinear kinematic hardening rules in order to properly model experiments on real materials, see e.g. Armstrong and Frederick [4], Chaboche [5], Lubliner et al. [6]. This is especially true under cyclic loading conditions and when simulating experiments on solid materials subject to loading unloading and reloading processes, see for instance Auricchio and Taylor [7] and Chaboche [8]. However, the adoption of nonlinear kinematic hardening rules for plasticity models is not a trivial task to be accomplished in the computational procedures. In fact it poses a number of challenges if a fast and robust computational solution is to be pursued. As a matter of fact the investigation of fast and robust integration methods for nonlinear kinematic hardening models and complex loading conditions currently represents an active topic of research. At this regard see for instance Auricchio and Taylor [7], Chaboche and Cailletaud [9], Hartmann et al. [10], Dettmer and Reese [11], Nukala [12], Artioli et al. [13]. In the present article an integration scheme is applied which preserves a quadratic rate of asymptotic convergence in the simulation of plasticity models with nonlinear kinematic hardening laws. A comparative analysis is made between the linear and the nonlinear kinematic hardening assumption by selecting different types of material parameters. Some considerations are presented regarding the applicability of linear and nonlinear kinematic hardening rules in the computational simulation of material behavior. Finally, computational applications and numerical results are reported in order to illustrate the effectiveness of the algorithmic procedure.

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