Closed form solution of the return mapping algorithm in elastoplasticity

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ABSTRACT

In the present work a return mapping algorithm is discussed for small strain elastoplasticity boundary value problems with an exact closed form solution of the local constitutive equations, see De Angelis and Taylor [1]. Nonlinear kinematic hardening rules are adopted in modelling kinematic hardening behavior of ductile materials [2]. One of the advantages of the present algorithmic procedure is to reduce the local solution of the constitutive equations to only one nonlinear scalar equation. In the literature other proposals have been presented which reduce the local constitutive equations to one nonlinear scalar equation. However, in the present work a particularly simple form of nonlinear scalar equation is derived. In fact, herein the local constitutive equations are reduced to a single variable algebraic (polynomial) equation. Moreover, in the present approach due to the straightforward form of the nonlinear scalar equation the analytical solution of the algebraic equation is found in exact closed form. Accordingly, an advantage of the present approach is that no iterative solution method is used to solve the local constitutive equations in three-dimensional elastoplasticity.
An expression is derived for the consistent tangent operator associated to the proposed algorithmic scheme for three-dimensional elastoplasticity models, thus ensuring a quadratic rate of asymptotic convergence when used with the Newton Raphson iterative method for the global solution procedure of the structural problem, see [3][4].
Numerical applications and computational results are finally reported in order to illustrate the robustness and effectiveness of the proposed algorithmic procedure for different types of loading conditions. Accordingly, the robustness and effectiveness of the proposed algorithmic procedure is illustrated with specific numerical examples.

REFERENCES

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