A Return Mapping Algorithm for Non-Smooth Multisurface Plasticity based on Newton-Raphson Method with Line Search

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ABSTRACT

Elastoplastic materials represented by multiple yield surfaces require a robust numerical integration scheme of the elastoplastic evolution equations. The effectiveness of this algorithm influences the performance of finite element methods in engineering applications. This work presents a robust return mapping algorithm in general stress space for a non-smooth multisurface plasticity model. The algorithm is based on a numerical method for unconstrained optimization. In this scenario, it is adopted the Newton-Raphson method with Line Search. A consistent tangent modulus for a non-smooth multisurface plasticity model is also presented. The proposed return mapping algorithm deals with two problems observed in traditional implementations regarding the Newton-Raphson method: infinite iteration cycles and the inverse of singular/quasi-singular matrix. The former is overcome by using the Line Search strategy. The latter is overcome by adopting Singular Value Decomposition for matrix inversion, as the Hessian matrix can become singular or badly conditioned (quasi-singular). The robustness and effectiveness of the proposed algorithm are evaluated through numerical examples applied to the constitutive model used for modelling rocks, soils and concrete: Cap Model.

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