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A Return Mapping Algorithm for Isotropic and Anisotropic Plasticity Models Using a Line Search Method

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Abstract

The numerical integration of constitutive models in computational solid mechanics codes allows for the solution of boundary value problems involving complex material behavior. Metal plasticity models, in particular, have been instrumental in the development of these codes. Most plasticity models implemented in computational codes use an isotropic von Mises yield surface. The von Mises, or J_2, model uses a predictor-corrector algorithm - the radial return algorithm - to integrate the model. For non-quadratic yield surfaces, including anisotropic yield surfaces, no simple algorithm exists. This paper presents and analyzes a line search algorithm for the return mapping problem that shows excellent improvement over a Newton-Raphson model. Two non-quadratic yield surfaces - one isotropic and one anisotropic - are studied in this paper. The line search algorithm used for integrating the models is shown to be reliable and robust. The theory and implementation of the models, the details of the return mapping algorithm, and results that show the effectiveness of the method are presented. Finally, a few simple boundary value problems verify the implementation and show the impact of the models. For the the internal pressurization of a cylinder, the importance of modeling anisotropy correctly is shown.

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