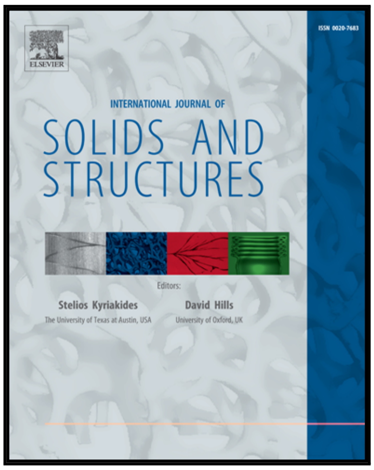

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An Evolving Effective Stress Approach to Anisotropic Distortional Hardening

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Abstract

A new yield surface with an evolving effective stress definition is proposed for consistently and efficiently describing anisotropic distortional hardening. Specifically, a new internal state variable is introduced to capture the thermodynamic evolution between different effective stress definitions. The corresponding yield surface and evolution equations of the internal variables are derived from thermodynamic considerations enabling satisfaction of the second law. A closest point projection return mapping algorithm for the proposed model is formulated and implemented for use in finite element analyses. Select constitutive and larger scale boundary value problems are solved to explore the capabilities of the model and examine the impact of distortional hardening on constitutive and structural responses. Importantly, these simulations demonstrate the tractability of the proposed formulation in investigating large-scale problems of interest.

Keywords: Anisotropic Hardening, Distortional Hardening, Yield Surface, Return Mapping Algorithm, Plasticity

1. Introduction

As computational capabilities for solid mechanics have continued to expand, there is a corresponding push to increase the physical fidelity of such analyses. In terms of constitutive models, this means incorporating additional features and/or physical mechanisms to better represent experimental observations. For structural metals, ubiquitous across a variety of fields, accomplishing this task requires looking beyond a von Mises, J_2 yield surface

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