Identification and Integration of Directional Distortional Hardening Model in Case of Monotonic Proportional Loading

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ABSTRACT

Distortion of yield surfaces due to plastic deformation of metals has been experimentally demonstrated by several authors [1,2]. A distorted yield surface exhibits higher curvature in the direction of loading, while it becomes flattened in the opposite direction. Such a behavior is referred to as the directional distortional hardening (DDH) [3,4].

A thermodynamically consistent DDH model extending the von Mises yield criterion was introduced in [4]. The model uses a fourth-order tensor-valued internal variable to capture yield surface distortion. Consequently, simplified versions of the model were published by same authors [5]. The simplest form defines the yield condition as

\[
\frac{3}{2} (1 - c\alpha) \left( \frac{s - \alpha}{\|s - \alpha\|} \right) (s - \alpha) : (s - \alpha) - k^2 = 0,
\]

where \(s\) is the deviatoric stress tensor, \(\alpha\) is the back-stress tensor, \(k\) is the isotropic hardening parameter, and \(c\) is the distortional parameter.

In order to use model in connection with return mapping algorithms, conditions for maintaining convexity of the yield surface (1) must be met as shown in [6]. These conditions are represented by restrictions on model's internal parameters and complement a set of restrictions for thermodynamic consistency.

The model can be completely integrated in analytical way. This treatment results in an analytical relation for stress-strain curve and may be used for analysis of the model and verification of numerical implementation. Moreover, a new option for identification of model's was developed by this integration.

REFERENCES