On the Prediction of Macroscopic Yield Surfaces of a Pearlitic Steel using Multiscale Modeling

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ABSTRACT

On the microscale, pearlite consists of hard and brittle cementite lamellae embedded in a ductile ferrite matrix. The cementite lamellae are arranged in colonies within which the lamella orientation is ideally constant. This composite-like constitution, on the microscale, makes pearlitic steels ideally suited for multiscale modeling.

In this contribution a three-scale multiscale modeling setup is used to describe the mechanical behavior of a pearlitic steel. The macroscale represents the engineering scale on which a typical structural component would be analyzed. The mesoscale comprises colonies, with varying orientations (both morphological and crystallographic), thereby enabling the interactions between colonies to be taken into account. On the microscale a model representing the lamellar structure of pearlite is used. This model accounts for the behavior of the constituents but also the interactions between them.

A cornerstone in this contribution is the formulation of a macroscopic, energy based, yield criterion based on homogenized quantities (cf. e.g. [1, 2, 3]). With such a criterion macroscopic yield surfaces can be predicted. The impact of altering the prolongation condition on the resulting yield surface is studied. Furthermore, the effect of adding a pre-loading before carrying out the yield surface prediction is investigated.

Regarding the topic of how to identify the correct values of the parameters in a multiscale model several possibilities exists. This topic will be discussed briefly.

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