

From dynamic shear localization until crack propagation in viscoplastic metals and alloys : a challenge for the modeling

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The fracture of high strength metals and alloys under impact and other high strain loading is often seen to be preceded by a stage of shear localization in the form of narrow bands called adiabatic shear bands. The latter are the consequence of a thermomechanical instability resulting from a competition between hardening and softening mechanisms. Leading to a premature failure, adiabatic shear banding (ASB) thus requires being taken into account for an accurate description of its consequences on the current and residual resistance of the structural material.

When attempting to describe ASB kinematic and material effects, the question of the representation scale is asked, in particular concerning the characteristic length of the representative volume element (RVE) and further finite element (FE) with respect to the bandwidth. Does the RVE/FE need to be contained within the band or does the band need to be embedded within the RVE/FE ?

In parallel, if the hardening mechanisms are generally well known, there remains some lack of the knowledge of the respective/combined contributions of the softening mechanisms which may potentially trigger the ASB process. Among these sources of thermomechanical softening one can notably cite dissipation-induced temperature rise and microstructural changes (DRC, DRX). Criteria for ASB onset, numerous in literature, mostly involve critical values of strain, strain rate, temperature rise, energy, etc. The criteria in question are generally empirical and are consequently only suitable for specific configurations. However, for an instability occurrence criterion to be robust, it must/should necessitate no further information than this already provided by the constitutive equations.

Describing the following stages of damage and crack propagation in the wake of the band is also of major interest.

These issues are discussed.