ABSTRACT

When a ductile material is subject to severe strain, failure is preluded by the emergence of shear bands, which initially nucleate in a small area, but quickly extend rectilinearly and accumulate damage, until they degenerate into fractures. Therefore, research on shear bands yields a fundamental understanding of the intimate rules of failure, so that it may be important in the design of new materials with superior mechanical performances.

Modelling of a shear band as a slip plane embedded in a highly prestressed material and perturbed by a mode II incremental strain, reveals that a highly inhomogeneous and strongly focused stress state is created in the proximity of the shear band and aligned parallel to it. This evidence, together with the fact that the incremental energy release rate blows up when the stress state approaches the condition for ellipticity loss, may explain the rectilinear growth of shear bands and the reason why they are a preferred mode of failure for ductile materials.

The same mathematical tools developed for the analysis of shear bands in ductile materials will be shown to lead to folding and faulting in constrained Cosserat materials, when these have a strong anisotropy, so that they are close to the elliptic boundary. In fact, folding is a process in which bending is localized at sharp edges separated by almost undeformed elements and folding in these materials can originate from ellipticity loss. Shear banding is shown to inspire tensile buckling of an elastic rod and development of configurational, or 'Eshelby-like', forces leading to models of snake locomotion and self-restabilization.

MIDWEST MECHANICS SEMINAR SERIES

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