Slip surfaces, tensile buckling, and shear bands

Davide Bigoni[1]

[1]*DICAM,Università di Trento, Trento, Italy*
E-mail: *davide.bigoni@unitn.it*

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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.

The modelling of a shear band as a weak slip surface in a highly prestressed material and perturbed by a mode II incremental strain, reveals that a highly inhomogeneous and strongly focussed 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 [1].

The modelling of a shear band leads to the concept of tensile buckling, occurring in slender rods in the presence of sliding constraints, which enhance shear deformation [2]. A sliding surface in a prestressed material is governed by equations which differ from the conditions of shear band formation, but explain tensile buckling [3]. The two phenomena are presented in detail and consequences of the two models are highlighted.

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