DYNAMIC DAMAGE, STRAIN LOCALIZATION AND FAILURE OF DUCTILE MATERIALS

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A challenging problem in solid mechanics is to understand the complex interaction between inertia effects and material properties that is taking place in the failure of ductile metals subjected to high loading rates. In this presentation, we investigate the dynamic signature that characterizes strain localization, ductile fracture and damage at high loading rates and we expose some perspectives.

The role of inertia in the development of viscoplastic flow instabilities such as multiple necking and multiple shear banding will be first discussed. Next, we analyze the evolution of strain localization towards fracture. The influence of material defects and of unloading waves in the selection of fracture sites will be reviewed in the light of numerical simulations, analytical approaches and experimental results.

At the micro-scale, elementary mechanisms of deformation can be significantly influenced by inertia. For instance, under dynamic conditions, the growth of micro-voids and the coalescence process are affected by local inertia effects that slow down the void expansion and modulate the way the voids interact together. A multiscale modeling is proposed that encompasses micro-inertia effects. This model is used to predict the internal damage by spalling observed in plate impact experiments and to get a new insight in the analysis of dynamic crack growth in fracture mechanics.

Keywords: Dynamic failure; Strain localization; Micro-inertia effects; Micro-voids; Multiscale modeling;