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From ductile damage to ductile fracture in forming processes

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Introduction

In metal forming processes such as blanking and cutting, the material undergoes large deformations, leading to ductile failure, which is characterized by the formation of voids and the eventual formation of macroscopic cracks. In this research project these phenomena are analyzed from a macroscopic point of view.

Gradient elastoplastic damage model

The behaviour of the homogenized material (voids plus matrix) is obtained by assuming strain equivalence [1] with the elastoplastic matrix. A localization limiter is used to ensure mesh independent results, which leads to a coupled problem [2]. The damage evolution accounts for the fact that ductile failure is triggered by positive triaxiality states and plastic deformation [3].

Simulations on notched bars show that a higher triaxiality, i.e. small notch radius, translates in a smaller ductility. This is in accordance with experiments.

Industrial applications

To model industrial applications, e.g. blanking, the coupled problem, i.e. equilibrium plus nonlocal averaging, is implemented readily in an operator-split (staggered) manner. Adaptive remeshing is used for three purposes: (i) to trace the crack paths, (ii) to prevent large element distortions, (iii) to capture the large gradients in the localisation regions.

References: