Numerical modelling of crack initiating, growth and arrest in ductile materials

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Rupture of a B–Pillar.

- Experimental study on DP450 Steel,
- Numerical modelling of DP450 behavior,
- Damage regularization,
- Development of a numerical crack propagation method,
- Validation on complex testing.

Abstract:

When a car crash occurs, parts made with steel or aluminium sheets can tear up. Rupture of ductile materials is not reliably predicted yet, and so, many parts and tools have to be re-designed, which increases the production cost. Ductile material behaviour was studied in many scientific works, in which comparisons between numerical simulation and experiment are made. Unfortunately, numerical methods used for making such comparisons are not adapted to an industrial context. In particular, computation time is excessive for the development of new cars. The aim of this work is to identify and develop a numerical method reliable and efficient which will enable the prediction, using the Finite Element Method, of the ductile tearing occurring on parts made with steel and aluminium sheets. The objectives are defined by two important issues: predicting the crack initiating and growth, which correspond to local phenomena occurring in a small scale (< mm), and keep the computation time compatible with dynamic simulations on car structures in a large scale (> mm). Regarding the behaviour till the crack initiating, softening constitutive models for damage in large strain require the use of a damage regularisation method to avoid pathological mesh dependency. Concerning the crack growth, element deletion usually used is not reliable enough. The XFEM methods are not able to gasp local phenomena enough, required for estimation of the crack initiating criterion and growth without prior remeshing. For this work, the idea is to use a recent and innovative remeshing method to gasp these local phenomena and, in the same time, to catch the crack front and lips with an optimum compromise precision/cost.