Variational fracture mechanics

The fracture pattern in stressed bodies is defined through the minimization of a two-field pseudo-spatial-dependent functional, with a structure similar to that proposed by Bourdin–Francfort–Marigo (2000) as a regularized approximation of a parent free-discontinuity problem, but now considered as an autonomous model *per se*. Here, this formulation is altered by combining it with structured deformation theory, to model that when the material microstructure is loosened and damaged, peculiar inelastic deformations may occur in the representative volume element at the price of surface energy consumption. This approach unifies various theories of failure because different-in-type responses can be captured, incorporating the idea of cleavage, deviatoric, combined cleavage-deviatoric and masonry-like fractures. Remarkably, this latter formulation rigorously avoid material overlapping in the cracked zones.
Moreover the variational model approach is extended to represent the phenomenon of plastic slip. The variational approach can interpret the onset of plastic deformations modelled as displacement jumps occurring along slip surfaces at constant yielding stress.
Numerical experiments for some paradigmatic examples are presented and compared for various possible versions of the model.

Bourdin, B., Francfort, G. A. and J. J. Marigo, Numerical experiments in revisited brittle fracture. J. Mech. Phys. Solids, 48, 797-826 (2000).