Ductile failure modelled by a non-local damage approach coupled with XFEM

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ABSTRACT

Ductile fracture is characterised by the presence of moderate to large plastic deformations prior to the degradation mechanisms, and therefore all these phenomena should be considered for a successful prediction of failure. Both Continuum Damage Mechanics and Fracture Mechanics address the material failure but from distinct paths. However, when it comes to ductile fracture, a unified approach is quite beneficial for an accurate modelling of this phenomenon. In the Continuum Damage Mechanics approach damage is regarded as an internal variable, which participates in the inelastic dissipative process, keeping damage and plasticity strongly coupled and, therefore, the internal degradation phenomena are described by continuum theories. The strain-softening behaviour introduced by the presence of damage permits to identify critical zones in the material where failure is likely to occur. Nevertheless in the final stages of failure, a discontinuous methodology, closer to Fracture Mechanics, is essential to represent surface decohesion and macro-crack propagation.

The main goal of this work is to combine a continuous–discontinuous model for crack initiation and propagation in ductile metals, based on the XFEM, whose accuracy of results may be competitive with remeshing. Initially the Continuum Damage Mechanics is used to describe the material behaviour prior to critical damage and, once this stage is reached, a discontinuity is inserted through the XFEM following geometrical and energy considerations. The subsequent crack propagation is also governed by the evolution of damage until the final stage of failure. The model is built under a finite strain assumption and a non-local damage formulation is used to avoid pathological mesh dependence. The efficiency of the proposed methodology is evaluated through various numerical examples [1].

REFERENCES

[1] Mariana R. R. Seabra, Primoz Sustaric, Jose M. A. Cesar de Sa, Tomaz Rodic, "Damage driven crack initiation and propagation in ductile metals using XFEM", *Comput Mech* (2013) 52:161–179.