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GRADIENT DAMAGE MODELS APPLIED TO DYNAMIC DUCTILE FRAGMENTATION

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Our goal is to present a regularized model and numerical results for the dynamic fragmentation of ductile materials.

This work is divided in three main parts: the first one consists of modeling the evolution of a brittle material for a quasi-static loading using a variational approach; we then make the necessary changes for it to account for plastic deformation as in [2]; we conclude by moving from the quasi-static to the dynamic problem.

We suppose that the damage can be expressed by a scalar $\alpha \in [0, 1]$, damage is irreversible and that the stiffness $E(\alpha)$ is a decreasing function of damage.

Considering the energetic approach developed both to plasticity and damage mechanics, we can write a suitable expression for the total energy to couple these two phenomena:

$$\mathcal{E} = \int_\Omega \Big(\frac{1}{2}E(\alpha)(\varepsilon - \varepsilon^p)\cdot(\varepsilon - \varepsilon^p) + w(\alpha) + \sigma_Y(\alpha)\bar{p} + \frac{1}{2}w_1\ell^2\|\nabla\alpha\|^2\Big)d\Omega \tag{1}$$

The dynamic behavior can be described by the wave equation. In [3], the damage evolution was found by minimizing the total energy. We follow the same idea in this work, but we also consider the plastic strain. When comparing to results obtained for a quasi-static loading, the main difference is that we are now able to obtain multiple cracks. The effects of plasticity can be seen in the direction of cracks.

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