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Illustration of the weakness of the delayed damage model for dynamic loading

Jihed Zghal¹ and Nicolas Moës^{2,3}

¹ Laboratoire EnergetiqueMecanique Electromagnetisme (LEME), University of Paris

Nanterre, 50 rue de sèvres 92410 Ville d'Avray, France

² Ecole Centrale de Nantes, GeM Institute, UMR CNRS 6183, 1 rue de la Noë, 44321

Nantes, France

³ Institut Universitaire de France (IUF), France

(jzghal@parisnanterre.fr, nicolas.moes@ec-nantes.fr)

The delayed damage model has been introduced by Allix and Deü [1] as a way to overcome spurious mesh dependency in failure analysis involving damage and dynamic loading. The damage rate is bounded through a time scale which, combined with the wave speed, introduces implicitly a length scale. In this work, the delayed damage model is analyzed through numerical experiments on three different loading cases of a bar: a slow loading leading to a dynamic failure, pulses, and impact. We observe and discuss the load level needed for failure (and the dependence of this load level with respect to the loading rate), as well as the dissipation and extent of the fully damaged zone at failure [2]. Observations lead to the following conclusions:

- First, the delayed damage model has no regularization effect for a dynamic failure initiating from rest.
- Second, for pulse loadings, the loading rate has no influence on the minimal load level needed for failure (even though the delayed damage model is a time-dependent model), and beyond this minimal load level for failure, the extent of the fully damage zone rises, proportionally to the length scale.
- Third, regarding the impact, the velocity needed to reach failure depends only the time-independent parameters of the models, and not the ones linked to the delayed damage.

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