

Dynamic cracks initiation, propagation, coalescence, speed and arrest from anisotropic damage mechanics analysis

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Continuous anisotropic damage is a quite natural modeling of material degradation when structural computations have to be performed. Loading induced damage in quasi-brittle materials such as concrete is strongly anisotropic [1] and strain localization in structures most often leads to an oriented cracking pattern. A five parameter anisotropic damage model has been proposed [6], taking advantage of the induced anisotropy. The damage is represented by a second order tensor. Its evolution is governed by the positive strains (the extensions) in a framework independent formulation, fulfilling the second principle of thermodynamics. The mathematical properties of the model (for instance a thermodynamics potential which can be continuously differentiated) have allowed for robust computations in quasi-statics. Mesh independence is gained from nonlocal integral enhancement.

In dynamics and impact applications, the so-called strain rate effect, of an apparent increase of the ultimate stress, has to be taken into account. This is simply done here in the visco-damage framework [2, 3, 4] by considering an anisotropic delay damage law bounding the damage rate at high strain rates [5]. Such a kind of evolution law regularizes the computations (with no need of non local averaging). One first presents computations of Hopkinson bar tests on concrete illustrating this feature. Then is presented the computation of Pontirolli's structural example of a blast impacted reinforced plate [7]. Such an example is quite nice to point out the possibility of continuous anisotropic damage modelling in dynamics:

- cracks initiation by stress softening and strain localization, with no need of initial flaws in Continuum Damage Mechanics analyses,
- cracks propagation as the propagation of localized damage zones,
- cracks coalescence and bifurcation, naturally taken into account from the continuum mechanics approach and the damage evolution law,

A multiple cracking pattern is obtained at the end of the computation, some cracks following the steels bars, some others not. The computation exhibits some cracks arrest. The cracks speed is shown smaller than Rayleigh's wave speed.

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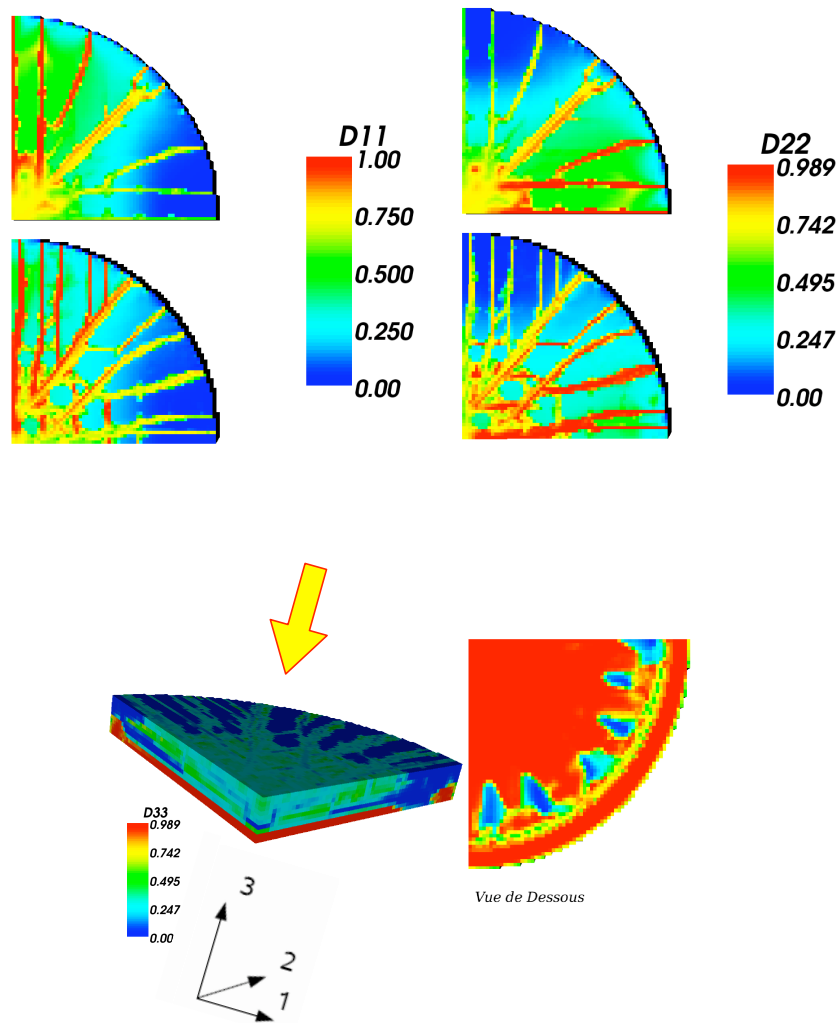


Figure 1: Anisotropic damage maps (RC plate).

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