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Non linear viscoelasticity in a plastic damageable aggregate material sensitive to hydrostatic pressure

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ABSTRACT

This paper deals with the characterization of the static mechanical behaviour of an energetic material [1]. Due to the components (crystals with a polymeric binder), the behaviour is sensitive to the pressure, the temperature and the strain rate applied. The principal aim is to develop a constitutive behaviour law to predict the material response under cyclic solicitations.

In a first study, the mechanical behaviour was supposed to be elastic-viscoplastic damageable with a strong sensitivy to hydrostatic pressure [2]. This first approach gave good results, particularly on the plasticity level and the pressure effect. More recent test results – such as DMA analysis, creep-recovery tests, and standard multicycle tests with recovery phases - highlight strong viscoelasticity. Inspired by the Visco-Scram model [3], a new generalized Maxwell model has been developed, using 10 viscoelastic branches providing a better description of the strain rate effects. Another branch, with a non associated plastic damageable behaviour, reproduces the plastic part of the material response. This viscoelastic plastic damageable model is able to describe recovery phases (strain evolution after complete unloading) of the mechanical tests; the viscoelastic parameters have been identified by means of DMA analysis.

This constitutive model gives good results but some limits can be listed:

- the shape of the unloading cycles is too linear (fig. 1),
- the creep and recovery phases are difficult to reproduce,
- the difference between the computed monotonous tests and the cycled tests (fig. 2) does not appear on the experimental curves.

To overcome such difficulty, a non-linear viscoelastic model is proposed in this study.

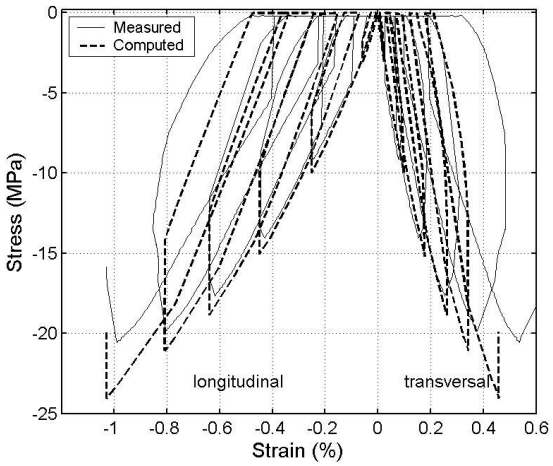

Figure 1 : Compressive test: Model versus test response at 20°C and $8.3.10^{-4}$ s^{-1}

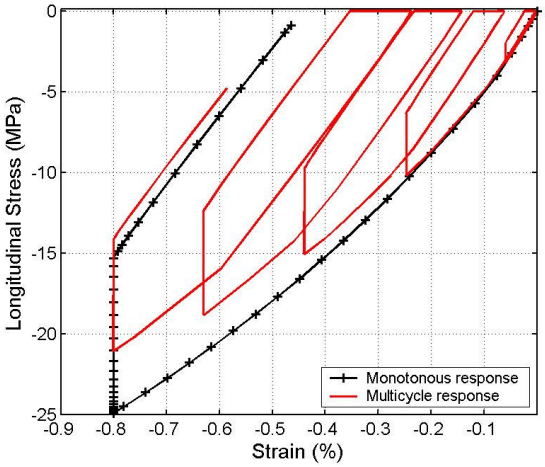

Figure 2 : Computed of compressive tests: Difference between the monotonous and the cycled responses at 20°C and $8.3.10^{-4}$ s^{-1}

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