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FINITE ELEMENT IMPLEMENTATION OF A STRAIN RATE SENSITIVE MODEL FOR IMPACT SIMULATION

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Polymer based composite materials are strain rate sensitive due to the nature of their matrix [1]. In order to improve the design and the understanding of the effect of such characteristics in structural applications it is mandatory to take into consideration this phenomenon in the numerical models used for structural analysis.

Literature review shows that unidirectional and woven composite material are strain rate sensitive mainly in the off-axis directions (this is demonstrated for glass and carbon reinforcements) to the stiffness, flow stress, failure strengths, failure angle, fracture toughness and damage evolution. In according to the experimental evidence, there are proposals to handle these phenomena numerically by means of finite element codes.

In this work, we propose a 3D mesoscopic progressive damage model that takes into account strain rate effects over the flow stress, the pre and postfailure material degradation (damage) and the failure strengths. The pressure dependent yield surface proposed by Wang and Xiao [2] is adopted. The flow stress is represented by means of a Perzyna type hardening law as done by Chen and Morozov [1]. The strain rate dependent failure criterion is also adopted from [1]. The damage is modelled by a strain rate dependent extension of the Ladeveze et al. damage model [3], developed during this research. These phenomenological models has been implemented into the non-linear implicit object-oriented finite element code Metafor (developed at the LTAS/MN2L, University of Liège, Belgium – www.metafor.ltas.ulg.ac.be).

The results are successfully compared with experimental data available in the literature. The incorporation of the strain rate dependent damage model is helpful to improve the accuracy and to understand the effect of the strain rate over the damage evolution during dynamic loads.

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