Title

NUMERICAL MODELLING OF STRAIN RATE EFFECTS ON A WOVEN COMPOSITE FABRIC

Abstract text

Composite materials are more and more used in aircraft industry for classical structural parts. Such kind of structures can be subjected to large dynamics loads due to bird or ice impacts. Efficient numerical tools are then compulsory in order to optimise their design.

The composite of interest is a woven carbon fibre preform which is moulded by using epoxy resin injected with the RTM process. This paper describes first the methodology of experimental characterization which has been done from quasi-static to dynamic loadings. The composite has been tested in each fibre direction as well as in shear thanks to creep tests and quasi-static loading/unloading tests. Three main non-linear mechanisms have been identified: the simultaneous growth of damage, due to matrix micro cracks which is leading to stiffness loss, the presence of inelastic strains and the effect of the matrix viscosity. The loading/unloading tests have already shown another feature to consider: the micro-cracks are closing in compression. That leads to develop a model in which tension and compression must be distinguished. Concerning the dynamics tests, we propose an original test which is based on a specific crossbow device. Indeed, the Representative Volume Element of our composite is thicker than usual materials and requires a new way to measure the dynamic characteristics.

In a second part, we present the general modelling adopted in order to describe the behaviour of this material from quasi-static to dynamics loadings. The model is based on the work done from French Aerospace Lab, ONERA and is named ODM model. It takes into account all quasi-static phenomena observed during the experiment. The numerical simulations shows good agreements with experimental data, but this model doesn't take well strain rate effects on damage. We thus propose to introduce a dynamic spectrum into the existing nonlinear spectral viscosity of the ODM model in order to improve this modelling. The aim is to provide a single model which is able to describe the behaviour of the woven composite both in static and in dynamic cases. We also propose a "simplified" model based on classical theory in order to provide another tool whose objective is to optimize the computational time in a point of view of the numerical simulations.

The last part of this paper concerns numerical simulations about some structures and the discussion of the results coming from both adopted models. That will allow us to conclude about the reliability of the proposed developments and about the future prospects.

Keywords

INTERLOCK, HIGH STRAIN RATE, CROSSBOW DEVICE, BIG RVE, ODM MODEL

Authors 5

GULDNER, GULDNER (GEM (ECOLE CENTRALE DE NANTES) // STRUTURES ET SIMULATIONS)

ROZYCKI, PATRICK (GEM (ECOLE CENTRALE DE NANTES) // STRUTURES ET SIMULATIONS)

GORNET, LAURENT (GEM (ECOLE CENTRALE DE NANTES) // STRUTURES ET SIMULATIONS)

CARTRAUD, PATRICE (GEM (ECOLE CENTRALE DE NANTES) // STRUTURES ET SIMULATIONS)

MARCIN, LIONEL (SNECMA VILLAROCHE // MATÉRIAUX ET PROCÉDÉS)