

Non-linear micromechanics based analysis of a satin5 representative single ply volume element

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ABSTRACT

An accurate determination of the local stress and strain distributions at the level of the yarns and matrix in woven composites is needed, in order to improve our understanding, hence our predictive capability of the damage and failure mechanisms under various loading conditions. The emphasis in this work is put on using non linear constitutive models for the matrix response inside the yarns and in resin rich pockets. The focus of this contribution is set on in-plane shear loading conditions which leads to large local deformation of the matrix.

The parameters of the matrix come from an extensive experimental characterisation of the RTM6 epoxy behaviour [1]. The behaviour of the yarns is modeled through a non linear homogenization of the behaviour of the matrix and the fibers at each increment. This technique provides the stress and strain levels in the fibers and in the matrix inside the yarns and in resin rich pockets.

An extensive comparison between a representative volume element (RVE) of a yarn and the results of the homogenization method is performed in order to assess the predictions of the homogenization scheme. This comparison shows the limit of a mean-field approach for the prediction of the elasto-plastic behaviour of a UD composite having a high fiber volume fraction, a large ratio between the stiffness of the constituents and a complex behaviour of the matrix. A new methodology is proposed to generate acceptable predictions in a mean-field formalism.

Another difficulty of the prediction of the behaviour of woven composites is to produce adequate RVE [2,3]. In this study, we propose a technique based on non-conform unstructured meshing which allows the generation of RVE for any kind of geometry. The originality of the technique lies in the combination of the following features : assignment of material properties at the integration points, evolution of the material properties with the distance to the matrix-yarn interface and local mesh refinement.

This new technique for the generation of woven RVE combined with the new methodology for the homogenization of UD lamina is tested on a 5HS carbon/epoxy composite. We validate the quality of the RVE generation technique against experimental values of the elastic properties. We then show that a proper account of the elasto-plastic properties of the resin is mandatory in order to obtain satisfactory predictions of the experimental non linear behaviour of the composite under in plane shear loading.

REFERENCES

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