

Introduction

Resin infused composite products based on non crimp fabrics (NCF) are applicable for use in aerospace and automotive parts that demand a high mechanical performance. These stitch-bonded fabrics can be draped like woven fabrics, but do not show a significant drop in mechanical performance due to the absence of fibre undulation.

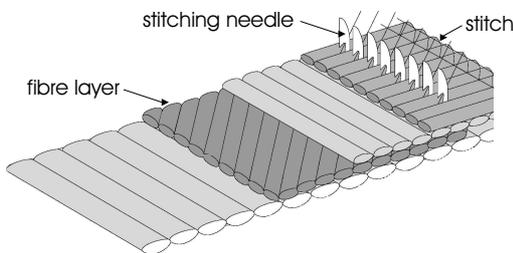


Figure 1 : A four layer non crimp fabric.

Product optimization

An optimal design of a NCF product can be found by modeling both processing and performance. The process of draping the NCF on the mould plays a key role in this optimization. Mechanical performance and injection times are dominated by the fibre distribution. A Finite Element (FE) model is developed to simulate the draping process of NCFs on arbitrary geometries.

Material and modeling

The model includes mechanical deformation mechanisms such as the stitch thread response and the response to shear deformation. The possibility of the individual yarns to slide through the stitches is an unconventional part of the deformation, when comparing with the more common woven fabrics.

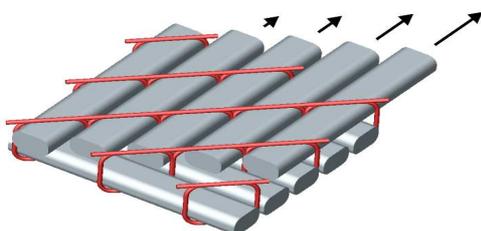


Figure 2 : Slipping fibres in a non crimp fabric.

Every stitch is interpreted as an obstacle that introduces friction. The stitches are attached to the elastic/plastic continuum that captures the other deformation mechanisms.

Simulations and experiments

An example of an experiment and the corresponding simulation can be found in Fig. 3. This bias extension experiment is performed on a biaxial fabric with fibres at $\pm 45^\circ$. Slip of the fibres causes the fabric to fall apart after a certain displacement. The failure cannot be modeled with the FE model, but the main slip lines are clearly visible. Fibre stresses increase along the fibre length due to the slipping phenomenon.

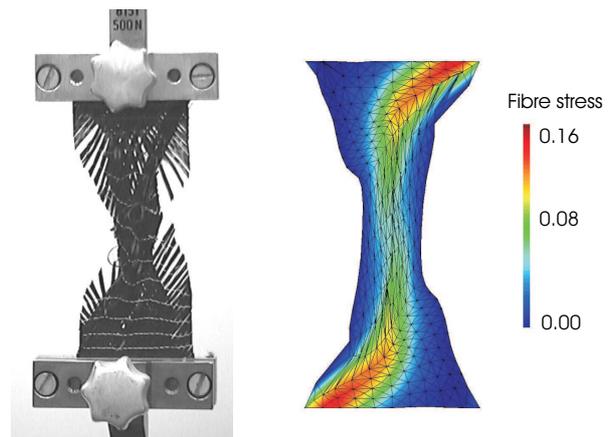


Figure 3 : Bias extension experiment and simulation.

Discussion and future work

The FE model is capable of simulating the 2D material experiments with the non crimp fabric. The model is extended to 3D and drape simulations on 3D products are carried out at this moment. The results will be compared to experimental drape results. The 3D simulations reveal stability problems of the obtained solutions and these problems are currently under investigation.

ACKNOWLEDGEMENTS This work was performed with the support from the European Commission, by means of the FALCOM project (GRD1-2001-40184). This support is gratefully acknowledged by the authors.