Virtual Description of a Biaxial 0/90° Non-Crimp Fabric with Normally Distributed Filament Directions

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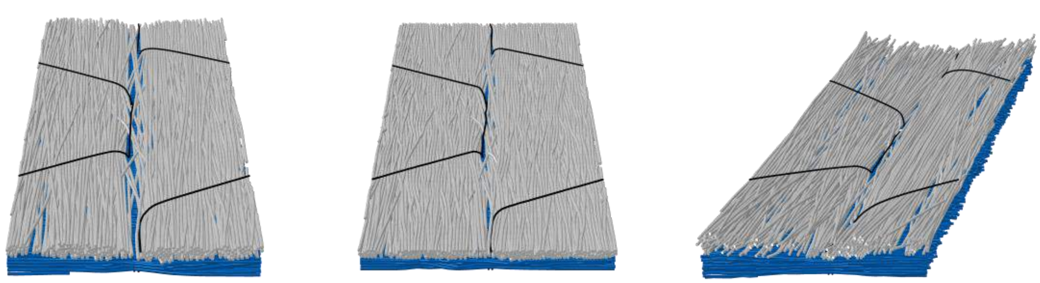
Abstract. The use of dry carbon fiber reinforcements in the resin transfer molding process enables high production rates of carbon fiber reinforced plastics. Among them, Non-Crimp Fabrics (NCF) exhibit a good handling capability and drapeability, while ensuring a high stiffness of the manufactured parts [1]. Nevertheless, precise knowledge of the deformation behavior is required to avoid local defects in the component. Experimental methods have been developed to characterize the mechanical behavior of dry textiles [2]. However, they remain time consuming and require the expensive production of many samples to find the optimum textile manufacturing parameters. A numerical description of the reinforcement at the scale of the filaments should be able to predict its mechanical behavior [3,4]. A previous study has shown that the idealization of the fibrous mat in homogeneously and perfectly aligned group of filaments can reproduce the kinematics of the textile but it is not sufficient to capture the internal interaction mechanisms [5]. The study at hand presents the model of a 0/90° biaxial tricot-chain NCF using digital chain elements with normally distributed filament directions in order to reproduce the entanglements of the filaments and their deviation from the ideal 0/90° paths. Averaged boundary conditions have been developed to apply a periodic deformation on digital chains randomly oriented. These models have been subsequently used to virtually test the most relevant deformation modes of the textile. Figure 1 (a) presents a visualization of the unit cell finite element model, referred to as the "as-manufactured" geometry. Figure 1 (b) and Fig. 1 (c) represent the simulation results when compacted to 40% fiber volume fraction and sheared to 18°, respectively. The results show a reproduction of the deformation behavior as expected from physical tests. Moreover, it has been found that the resulting forces are very sensitive with respect to the distribution used to generate the direction of the digital chains.



(a) (b) (c)

FIGURE 1. As-manufactured geometry of the textile (a) with simulation results at a compaction of 40% fiber volume fraction (b) as well as sheared to 18° shear deformation (c).

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