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Numerical modelling of entangled-cross-linked material under compression and shear cycling

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A new entangled-cross-linked material based on carbon fibres has been developed as a new core material that can resolve drawbacks of the honeycomb [1,2]. It offers many advantages such as open porosity, adaptability to complex structures, and good vibration damping. Mezeix et al. [2] have concluded that this material cannot yet substitute for honeycomb in the aerospace field due to its low stiffness for compression solicitations and Piollet et al. [3] have noticed, through experimental measurements, how its use can increase damping in sandwich structures. In order to understand its mechanical behaviour and to optimize it, a 3D finite element model is proposed to investigate the influence of morphological parameters on the macro-mechanical behaviour. In the literature, limited researches have been conducted to study and understand these fibrous materials because of their complex tangled geometry. Model networks composed of bonded fibres of arbitrary distribution in length, curvature, cross-section, stiffness and strength were investigated by Heyden [4]. Beil et al. [5] proposed a model which predicts the effects of the mechanical hysteresis during pressure release cycling; he concluded a distinct loss of energy to friction that decreases as the cycling proceeds. The current work focuses on a representative volume element (RVE) of the material previously tested [1-3] and made by entangling carbon fibres whose junctions are partially glued. The key points of this study are the appropriate boundary conditions, the initial fibre distribution close to that of the experimental test, the proportion of blocked junctions and the friction coefficient. Simulations have been run to reproduce the experimental data, not only the mechanical behaviour during static compression [2], but also the hysteresis measured during shear cycling [3]. After this step, the influence of the various micro-parameters on the global mechanical performance is also studied.

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