COMPUTER MODELLING FOR THE PREDICTION OF THE IN-PLANE PERMEABILITY OF NON-CRIMP STITCH BONDED FABRICS

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ABSTRACT

The prediction of permeability of fibre preforms as a function of structural parameters and architecture is important in the design of fibrous textiles and processes for composites manufacturing and gives a detailed insight of the local variation of permeability as a result of structural variations between different batches of textile or even within the same batch. A large number of modelling studies have been performed by several researchers to predict the permeability of unidirectional fibre preforms, empirical models have been coupled with experiments to determine empirical parameters such as the Kozeny constant, and as a conclusion one could say that there has been established a good base within the composites and textiles communities in this area for the next stage of models for more complex fibre architectures. The case of non-crimp fabrics has been considered the next stage for our group, given also the computer model developed within our group for a two-scale porosity, unidirectional fibre porous medium [S.C.Amico, PhD thesis, 2000].

A multi-layer model was constructed for the prediction of the in-plane permeability of a corresponding preform consisting of unidirectional fibre layers of different orientations. Due to the presence of the stitch, each fibre layer contained meso-flow microchannels periodically dispersed in the closely packed array of fibres. A Stokes's flow model is applied to the meso-flow and Darcy's model is applied to the micro-flow with flow transfer between the two flows. Due to the significant volume of meso-flow, inputting the accurate geometry of meso-channels in terms of either average dimensions or shape has proven crucial to obtain good correlation with experimental data. When the meso-channel geometry was accurately modelled and measured, excellent agreement was obtained between numerical predictions of the permeability of non-crimp stitch bonded fabrics and experimental data.