# A Permeability Prediction for (Un)Sheared Non-Crimp Fabrics

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**ABSTRACT**

Resin Transfer Moulding (RTM) is a cost effective production method for complex near-net shaped composite products. Non-Crimp Fabrics (NCF) offer benefits compared to woven fabrics, due to better crimp and drapeability properties. A rapid and robust design procedure will include filling simulations before the RTM tools are manufactured. The permeability of the pre-form is a necessary input to these simulations. However, accurate permeability prediction models of NCFs are unavailable yet. The permeability model developed at the University of Twente aims to predict the permeability value of Non-Crimp Fabrics in relaxed and deformed state (due to draping and compaction) employing a geometrical description of the NCF material. This geometrical model describes the dimensions of distortions in the fibre layers induced by the stitch threads piercing through the fabric. These stitch yarn distortions form a network of flow domains and, as a consequence, their dimensions determine the permeability of the NCF. Variations are observed in the dimensions of the stitch yarn distortions. Measurements show that the averaged value of the dimensions as well as the distribution changes under deformation of the fabric. These variations directly affect the permeability. As a result, the permeability can be specified as an averaged value plus a distribution, which both depend on the amount of deformation of the fabric. The distribution of the dimensions complicates the permeability prediction, since a complete network of flow domains has to be analysed, rather than a single flow domain with averaged dimensions. A fast multigrid solver is implemented to solve the flow equations in the flow domains. This fast solution algorithm allows the analysis of relative large networks within a reasonable span of time. The permeability distributions found from these simulations and permeameter experiments will be critically discussed and compared with results from moulding of more complex shaped parts.