A Permeability Prediction for Non-Crimp Fabrics

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Introduction

Resin Transfer Moulding (RTM) is a closed mould production method for composite products. A dry fibre reinforcement is placed in a mould after which resin is injected and cured. Non-Crimp Fabrics (NCF – Figure 1), built from unidirectional layers of fibres, stitched together, are a widely applied reinforcement. This research aims to improve the permeability prediction of these fabrics for modelling of the RTM process, which now suffers from large variations in the measured permeability values.

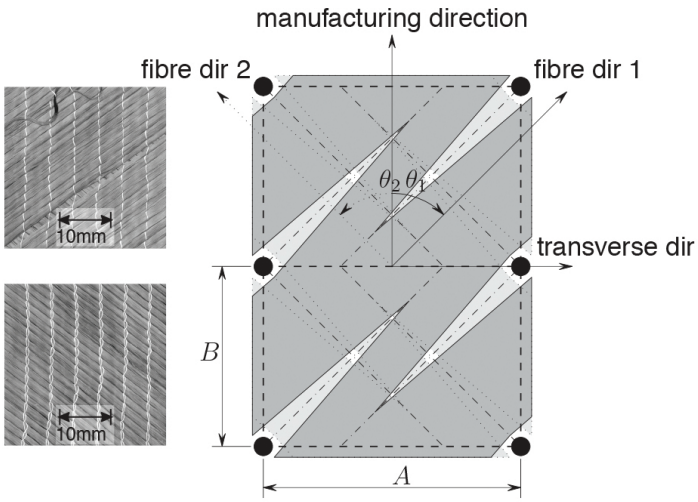


Figure 1: *Top and bottom side and schematic representation of a biaxial Non-Crimp Fabric ($\theta_i = \pm 45^o$)*

Objective

Investigate whether inherent variability of the internal geometrical structure of a Non-Crimp Fabric can explain the variability in the permeability.

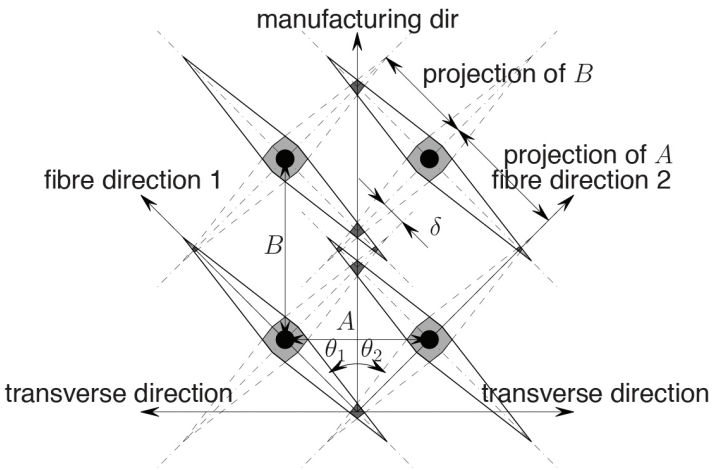


Figure 2: *Schematic representation of the channels of a biaxial NCF ($\theta_i = \pm 45^o$).*

Methodology

Channels ($\sim$mm) are formed during manufacturing of the fabric, as shown in Figure 2. The channels are mutually connected and form a network through which the resin flows. A finite element approach is adopted to solve the flow.
The variability of the internal geometry is incorporated by applying a distribution on the channel resistances, depicted in Figure 3.

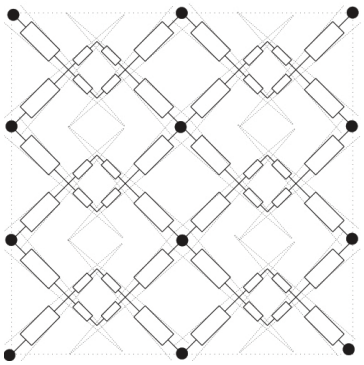
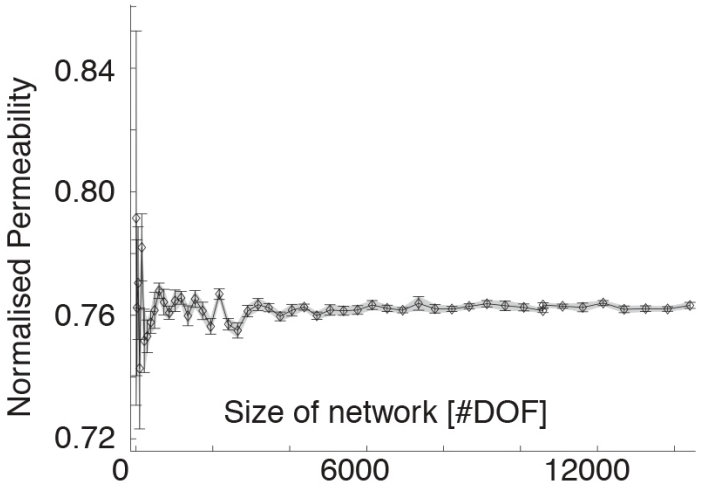


Figure 3: *Network of flow resistances representing the flow domain. The dots: centers of the wedge shaped domains(dashed lines).*

Results

The averaged permeability converges to $\approx$76% of the permeability with uniform resistances. The variability of the internal geometry does not explain the variation in measured permeability values, but is significant for the value of the permeability.



Further Research

Firstly, a more accurate description of the flow channels and improvements on the distribution of the variability are to be investigated to improve the network model. Secondly, other possible causes of the variations in measured permeability have to be studied.

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