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# **Monitoring and Simulation of the Filling and Post-filling Stages of the Resin Infusion Process**

by

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# **ABSTRACT**

The doctoral research presented in this thesis is focused on the resin infusion moulding process. The resin infusion process is part of the liquid composite moulding family where a dry reinforcement is impregnated with a liquid resin inside a closed mould to form a composite part. The specificity of resin infusion resides in the fact that only one side of the mould is rigid, the cavity being sealed by a vacuum bag. The preform compaction and fluid flow are driven by the pressure difference between the cavity and the ambient pressure. The reinforcement can therefore exhibit through thickness deformation as the resin penetrates the cavity. The aim of the research was to monitor and simulate the process. A number of previous studies have considered the impregnation process, but very little work had focused on the post-filling stage of the process, once the resin inlet is closed and the resin pressure field inside the mould is left to equilibrate.

In the first part of this study, the behaviour of two different fibrous reinforcements was experimentally characterised, and a new model was developed to replicate the compaction behaviour of the reinforcements. This model is based on elastic behaviour, but was able to account for the compaction history of the reinforcement.

A comprehensive monitoring system was designed and built to collect relevant experimental data to be compared with the simulation. This included

the development of a mould fitted with sensors, as well as a stereophotogrammetry system which provides full field monitoring of variations in reinforcement properties. This system measures local cavity thickness, allowing calculation of other parameters such as fibre volume fraction and permeability.

A 1D finite element simulation of the resin infusion process is subsequently presented. The simulation covers both the filling and post-filling stages of the process and uses a modified version of Darcy's law to govern the flow of fluid through porous media.

Finally, an investigation of different factors affecting the post-filing is presented through both simulation and experimental evaluations.

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