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TITLE: Liquid Composite Moulding - Process simulation chain to structural analysis

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ABSTRACT:

Composite manufacturing processes involve multiple interconnected stages, each influencing the final part quality and performance. Accurate simulation of these stages is critical for reducing development time, minimizing defects, and optimizing material usage. This work presents a comprehensive simulation workflow for composite manufacturing processes using Finite Element (FE) analysis in Abaqus, integrated through Python scripting for automated chaining of process steps.

The proposed workflow simulates the entire manufacturing chain, as illustrated in Figure 1. The process begins with Preforming, where compaction, configuration, and lamination are modelled. Next, draping simulations capture forming and squeeze flow effects. Resin Infusion analysis predicts flow front progression, deformation, and saturation. Curing/Demoulding simulations incorporate cure kinetics, residual stress, and tool-part interactions. Finally, Structural Analysis evaluates damage initiation, propagation, and mechanical performance. Python scripting enables seamless data transfer between stages, ensuring consistency and reducing manual intervention. Abaqus serves as the primary FE platform for detailed physics-based modelling.

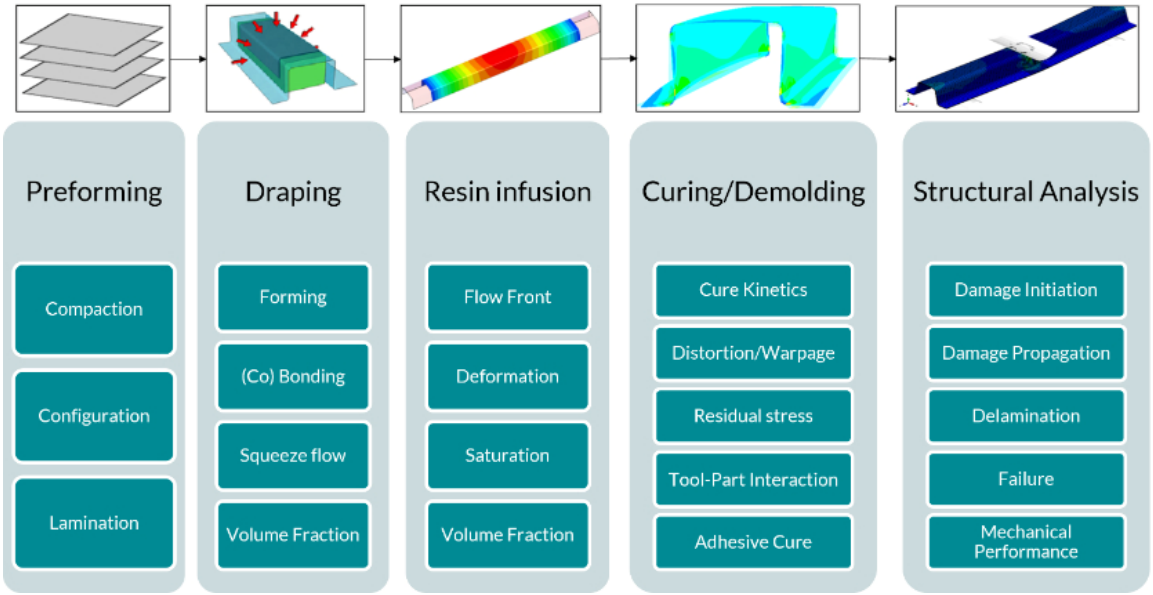

Figure 1: Simulation workflow for composite manufacturing processes

The integrated simulation approach provides predictive insights into process-induced defects, residual stresses, and structural integrity. By automating the workflow, engineers can perform rapid design iterations, optimize process parameters, and enhance reliability. This methodology supports the development of high-performance composite components for aerospace, automotive, and energy applications.