Compaction Simulation of Continuous Fiber Composites by Homogenisation and Finite Element Analyis

†Wei Huang[1], Ahmed Makradi[2], *François Trochu[1], Philippe Causse[1], and Salim Belouettar[2]

[1]École Polytechnique de Montréal, Canada.
[2]Luxembourg Institute of Science and Technology (LIST), Luxembourg

*Presenting author: francois.trochu@polymtl.ca
†Corresponding author: wei.huang@polymtl.ca

Abstract

A tightly coupled mesoscale and macroscale continuum model was developed for the analysis of the compaction of continuous fiber composites. The model for the Representative Unit Cells (RUCs) at the mesoscale level includes different elements of complexity such as material non-linearity, friction and contact. Decisions concerning the geometrical representation of the material, the physical phenomena considered, the Finite Element (FE) solver used, or the constitutive relations for the solid phase, namely the fibrous reinforcement of the composite, govern the accuracy of numerical solutions. As the FE model is improved to include some of the previously-mentioned effects, the computational cost increases. The accuracy versus cost of the FE homogenization technique must be consistent with the intended use of computer simulation. The proposed approach is allows determining by computer simulation the mechanical properties and permeability of high performance composites. A direct method based on X-ray tomography imaging is introduced to create realistic geometric models of the complex 3D textile architecture for finite element analysis. Based on the 3D voxel images of the fibrous reinforcement, the internal mesoscopic structure of the material can be identified and reconstructed. Two important stages of composite processing by resin injection can thus be investigated: (1) the mechanical response in deformation of fiber tows during textile compaction; (2) the liquid flow in the mesoscopic pores during resin injection, which allows evaluating the equivalent macroscopic permeability of the fiber bed.

Keywords: **high performance composites, X-ray microtomography, mesoscopic structure**