Simulation of isothermal RTM using Smoothed Particle Hydrodynamics

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Abstract

Resin Transfer Molding (RTM) can be a very attractive single-step process for sandwich structure manufacturing. The two fiber-reinforced skins and the core are laid up in a mold. Both skins are saturated and bonded to the core while resin is injected. There is no need for an extra adhesive bonding step compared to other sandwich manufacturing processes. During RTM, the pressure field developing while saturating the fiber-reinforced skins can lead to large translations or inelastic deformation of the core. Such effects are damaging to the part because they induce poor dimensional accuracy of both skin and core thickness. Also, filling time and injected resin amount can be greatly increased. This study particularly focuses on flow-induced foam core deformations during sandwich manufacturing. In order to model flow/deformation coupling, the use of mixed Finite Element and Smoothed Particle Hydrodynamics (FE/SPH) method is presented in this study. This method combines Lagrangian particles and finite elements, modeling respectively resin and sandwich core. The fluid response is transferred to the core through contact algorithms. The skins are modeled as porous regions in which the Lagrangian particles are evolving. The foam is modeled as a non-linear elastic material which is affected by the resin filling the skins. Computed pressure responses during the filling stage are compared to sandwich manufacturing test results. The potential of this original numerical method is discussed.