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PROCEEDINGS

Macroscopic Modelling Approach for Textile Reinforcement Forming

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ABSTRACT

The increasing use of composite material require more efficient and inexpensive manufacturing process analysis method to optimize the product quality. The manufacture of textile reinforced composites often requires the preforming of a dry textile reinforcement and the subsequent injection of a resin in Liquid Composite Moulding processes (LCM). The composite can also be produced by thermoforming a prepreg consisting of a textile reinforcement incorporating the unhardened matrix, so that the composite can be formed. In both cases (LCM and prepreg), the forming process is driven by the deformation of the textile reinforcement which is influenced by its fibrous composition.

Standard finite element methods based on classical plate and shell theories are not verified for textile reinforcement. The objective of this conference paper is to show that a fibrous shell approach based on the quasi-inextensibility of the fibers makes it possible to correctly model the deformation during forming. Therefore, a continuum mechanics-based 3D shell element is developed. The kinematics associated with the form of the virtual work taken into account reflect the specificity of the deformation modes of the fiber reinforcements (quasi-inextensibility of the fibers and the possibility of slippage between fibers). The rotation of the material normal is simulated in good agreement with the forming experiments. Besides, fabric's in-plane bending (IPB) behavior show also the influence on the simulation results. Numerical spurious mode involving in-plane shear is avoided due to the new approach. Fiber orientations and distributions of shear angles are simulated in good agreement with experiments and give better results than simulations neglecting the IPB behavior.

KEYWORDS

Fabrics/textiles; forming; preform; finite-element method

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