World Journal of
Engineering

World Journal of Engineering 7(1) (2010) 123-129

Textile composite forming simulations at meso and macro scale

N. Hamila, M.A. Khan, S. Gatouillat, E. De Luycker, E. Vidal-Sallé, T. Mabrouki and P. Boisse

Université de Lyon, CNRS INSA-Lyon, LaMCoS UMR5259.

Abstract

The finite elements presented in this paper for textile fabric forming are composed of woven unit cells. The mechanical behaviour of these is analyzed by 3D computations at the mesoscale regarding biaxial tensions, in-plane shear and bending properties. These elements are efficient because they are close to the physics of the woven cell while avoiding the very large number of unknowns in the discrete approach. Forming simulations on single ply, multi-ply and 3D interlock will be presented and show the efficiency of the approach. In particular the importance of the in-plane shear and bending behaviour will be emphasized.

***Key words**: Composite forming, Forming/draping simulations, Textile composite, Meso-macro*

1. Introduction

To accurately perform mechanical analyses of composite materials, it is necessary to know the direction and the density of the fibres at any point on the part. These directions are mainly dependent on the forming of the composite. Woven textile reinforcements can reach very large in-plane shear strain during manufacturing when the final shape is double curved. A numerical tool that simulates this forming process determines not only the conditions of the feasibility of a process without defect but also the directions of the reinforcements after shaping. In addition to the mechanical behaviour of the final solid composite, the angles between warp and weft yarns influence the permeability of the reinforcement and thus the filling of the resin in the case of a liquid moulding process (Bickerton *et al.* 1997, Hammani *et al.*, 1996; Loix *et al.*, 2008).

To simulate draping of textile composite reinforcement, several packages are commercially available based on "kinematical models" (VanDerWeen 1991). This method is very fast but does not account for the mechanical behaviour of the woven reinforcement for possible sliding of the fabric in relation to the tools and for load boundary conditions. These points are very important in the case of forming with punch and die (such as in the preforming of the R.T.M. process). A complete physical simulation of a composite forming process needs a model of the mechanical behaviour woven reinforcement and usually a numerical method, for instance, the finite element method. The mechanical behaviour of fabrics is

ISSN:1708-5284