III European Conference on Computational Mechanics
Solids, Structures and Coupled Problems in Engineering
C.A. Mota Soares et al. (eds.)
Lisbon, Portugal, 5–8 June 2006

Strength of Textile Composites – A Voxel Based Continuum Damage Mechanics Approach

Raimund Rolfes[*], Gerald Ernst[*], Daniel Hartung[†], Jan Teßmer[†]

[*]Institute for Structural Analysis, University of Hannover
Appelstraße 9a, 30167 Hannover, Germany
{r.rolfes, g.ernst}@isd.uni-hannover.de

[†]Institute of Composite Structures and Adaptive Systems, DLR Braunschweig
Lilienthalplatz 7, 38108 Braunschweig, Germany
{jan.tessmer, daniel.hartung}@dlr.de

ABSTRACT

Industrialised infusion processes enable a cost-effective possibility to produce textile composite structures compared to pre-impregnated composite systems (Prepregs). Particularly with regards to high performance structures one has to be familiar with the material behaviour and the failure characteristic to apply fibre reinforced composites profitable. In this publication a brief overview of the current research activities to characterise the mechanical behaviour, failure and strength of textile composites compared with prepreg systems is presented.
Unlike pre-impregnated and filament winding composites, textiles are different in their mechanical behaviour due to various fibre architectures of the preforms (braided, woven, stitched, tufted, etc.). Therefore, a finite element analysis of a representative volume element (unit cell) on a micromechanical level is a promising possibility to analyse the mechanical behaviour and to predict the material failure. Currently different approaches are used to account for many material characteristics. The first results of an approach, which considers a continuum damage model to predict the first micromechanical material failure, will be presented.
A lot of standards have been established to determine the material properties of Prepregs over the last years. Particularly textile composites require an adapted test setup to account for the characteristic material behaviour and to validate different failure criteria. The standards used to qualify a pre-impregnated material and a short description of the requirements for textile composites are presented. While many failure theories were developed during the last years, there are some weaknesses even by the most popular failure theories. The results of the World Wide Failure Exercise have shown that there is a demand for an accurate failure prediction also for prepreg composites. Especially the comparatively complex failure of textile composites requires an advanced failure theory. The fracture plane concept originally proposed by *Hashin* is a promising method to describe the failure behaviour of prepreg composites. A three dimensional failure model was developed based on a fracture plane by *Juhasz*, who considers the characteristic material behaviour of orthogonally reinforced composites. This criterion was implemented in a three dimensional finite element to account for the three dimensional stress state in each layer of a lamina by Kuhlmann and Rolfes [1].

References

[1] G. Kuhlmann and R. Rolfes, A hierarchic 3d finite element for laminated composites. *International Journal for Numerical Methods in Engineering*, **61**, 96–116, 2004.