INTERFACES WITHIN A FLAX FIBRE BASED COMPOSITE: CHARACTERISATION AND MODELISATION

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Summary. The interfaces present within a flax fibre based composites have been characterized and their mechanical behaviour has been numerically modeled using a cohesive zone model. The results show that both the fibre/matrix interfaces and the fibre/fibre interfaces have to be considered to estimate properly the composite properties.

1 INTRODUCTION

As flax fibres exhibit good mechanical properties and low cost, they are more and more considered, since the early 2000’s, as efficient reinforcement for polymer based composites in replacement of E-glass fibres in automotive or building areas. The properties of the elementary fibres are now relatively well-known (strength comprised between 600 and 2000 MPa, Young’s modulus around 50 GPa and failure strain about 2% [1,2]), but information about the mechanical behaviour of the interface between the fibres of a flax bundle is still missing. However, this phase is of crucial importance when modelling the global deformation of the derived composites, since the estimation of mechanical properties of a fiber bundle without taking into account the behaviour of interfaces leads to an overestimation of these properties. The only mechanical information available for flax bundles is their strength, evaluated at 500 MPa for gauge length above 20 mm [3,4]. A possible explanation for this lack of data may be the very small dimensions of these interfaces (less than 1 µm wide) and the minute section of the elementary fibres (around 20 µm in diameter) [5,6].

2 EXPERIMENTAL AND NUMERICAL PROCEDURES

In this study, the shearing properties of a pair of elementary fibres are experimentally and accurately determined in order to characterize the mechanical behaviour of the fibre/fibre interface assumed to be a cohesive zone. In parallel, the shearing properties of the fibre/matrix interface are determined using the classical micro-droplet test. The parameters of the cohesive zone model [7] are identified in both cases and their variability is studied. Then, numerical simulations using finite elements code ANSYS are performed taking into account the
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identified parameters in the properties of the contact elements. The geometric models are obtained by image analysis on micrographs of fiber bundles embedded in composites (Fig. 1). A first numerical model with a pair of elementary fibres is developed to validate the methodology. Then, a second model representing a bundle of about thirty flax elementary fibers is developed and numerical simulations are performed. Finally, these last numerical results are implemented at higher scale to determine the composite behaviour. The comparison between our experimental values and data available in the literature show good agreement and proved the relevance of our study.

Figure 1: Optical micrograph of flax bundle sections, showing the two types of interfaces at stake

REFERENCES