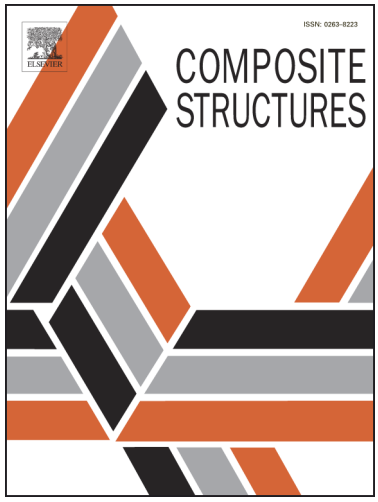

Analysis of the hydro-mechanical behaviour of flax fibre-reinforced composites: assessment of hygroscopic expansion and its impact on internal stress

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Analysis of the hydro-mechanical behaviour of flax fibre-reinforced composites: assessment of hygroscopic expansion and its impact on internal stress

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Abstract

The present work aims at modelling the hydro-elastic behaviour of twill flax fabric-reinforced epoxy composites. These latter were manufactured using the vacuum infusion technique and aged into tap water until saturation. Their heterogeneity is taken into consideration by modelling the twill weave fabrics with two geometric paths: [0/90] and elliptical undulation. Moreover, the water diffusion coefficient and the hygroscopic expansion parameter of the flax fibre are estimated by an inverse approach exploiting the experimental results. In particular, the finite element simulations reveal high mechanical stress concentrations especially at the fibre-matrix interface caused by the differential swelling between the flax fabrics and the epoxy resin. This water absorption-induced internal stress is the main cause of damage initiation in the flax-epoxy composites, which leads to high variations of their mechanical properties and reduces their long-term sustainability.

Keywords: *flax composite; water ageing; internal stress; finite element analysis*

1. Introduction

In the last years, the use of natural fibres as reinforcement of polymer composites in replacement of synthetic fibres has received growing attention. In fact, natural fibres offer several advantages such as their economic and renewable characteristics [1], interesting specific mechanical properties [2], good thermal and acoustic insulation properties [3] and recyclability [4, 5]. Unfortunately, all natural fibres are hydrophilic in nature which makes their composites very sensitive to humid environments [6]. Indeed, moisture absorption leads to hygroscopic swelling of natural fibres which degrades the fibre-matrix interface. Accordingly, moisture absorption decreases the mechanical properties and the long-term sustainability of natural fibre-reinforced composites [7, 8].

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