Abstract ICCM

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Track: 2-02 Fibres

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VISCOELASTIC BEHAVIOUR OF SINGLE HEMP FIBRE UNDER CONSTANT AND CYCLIC HUMIDITY ENVIRONMENT - EXPERIMENT AND MODELLING.

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Abstract text: Natural fibres derived from annual plants are attractive candidates to reinforce organic matrix in high performance composite applications. This use requires an accurate understanding of their mechanical properties and the development of efficient models. In the last years, many efforts were concentrated on the characterisation of the tensile properties of bast fibres under quasi-static loading. In contrast, the time-dependent behaviour has almost not been examined. However, considering the polymeric composition of the fibre wall, it is probable that the fibres have significant viscoelastic behaviour. This point is of great importance in view of their integration in composite materials. Contrary to glass or carbon fibres reinforced plastics, the time-dependent behaviour of natural fibres reinforced plastics could arise both from the matrix and the fibres. So, the integration of the viscoelastic behaviour of natural fibres in the predictive mechanical models of natural fibre and natural fibres reinforced composites is definitely necessary to ensure the reliability of the designed structures, in particular for long-term applications.

The aim of this study is to investigate and model the time-dependent tensile behaviour of single hemp fibres. This work proposes an experimental approach, using creep tests and Dynamic Mechanical Analysis under constant and cyclic humidity environment. A 3D anisotropic viscoelastic model based on a spectral distribution of elementary mechanisms is proposed to describe the time-delayed response of these fibres.

Single hemp fibres are shown to exhibit both instantaneous deformation and delayed, time-dependent deformation when tensile loaded. Under constant environment, three types of creep behaviour are observed (see Fig. 1). Our results show that an inverse Gaussian spectral model with truncation associated to a reliable parameters identification strategy is able to describe accurately the 3 types of creep behaviour.

The primary and secondary creep rates are also shown to be highly influenced by the stress level, the moisture level and moisture cycling. Much greater creep in cyclic humidity conditions than in a constant environment at the high-humidity is also observed. In agreement with some observations on synthetic fibres, we showed that this accelerated creep is only observed for high moisture cycling rates. This mechanosorptive effect is consistent with sorption-induced stress-gradient explanations proposed in literature.

Image/Graph:

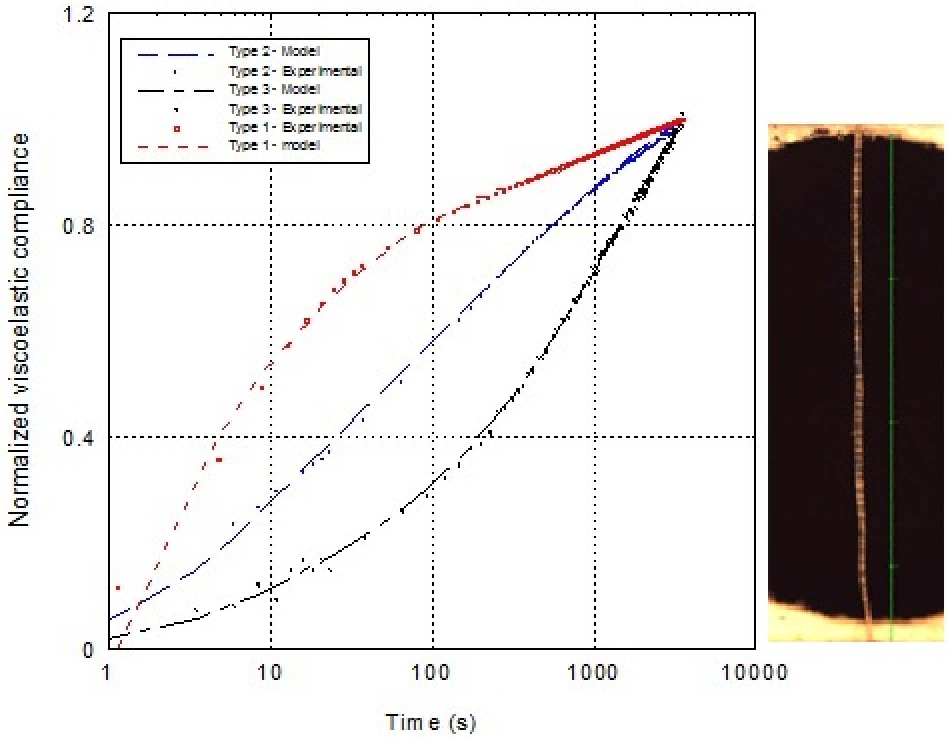

Image description: Three types of creep behaviour observed for hemp fibres. Experimental and model curves