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EFFECT OF THE MIDDLE LAMELLA BIOCHEMICAL COMPOSITION ON THE NON-LINEAR BEHAVIOUR OF TECHNICAL FIBRES OF HEMP UNDER TENSILE LOADING USING STRAIN MAPPING

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Abstract

This manuscript describes the effects of alterations in biochemical composition on structural morphology and the mechanical behaviour of technical fibres of hemp used for composite applications. First, the strength and apparent Young's modulus distribution of technical fibres of hemp of 96 hemp samples, corresponding to 32 different hemp accessions cultivated in 3 locations, were analysed using Weibull distribution. From these, 2 samples (one with high and one with low fibre strength) were selected for further analysis. Next, full-field strain measurement at the micro-scale during tensile loading via digital image correlation analysis was used for evaluating both, the stress-strain behaviour at a global scale and the local mechanical behaviour heterogeneity at a micro-scale, along a technical fibre of hemp. The analysis reveals 2 typical types of tensile stress-strain curves, and a complex and very irregular pattern of strain concentrations, which are associated to the technical fibre strength. The non-linear behaviour of the stress-strain curve is explained by the development of shear strain at the elementary fibre (botanically defined as the individual cell) interphases. Micro tomography and biochemical analysis of the technical fibre microstructure showed that alterations in cell wall composition, in particular substitution of pectin, leads to changes in the non-linear behaviour of technical fibres of hemp under tensile loading.

Keywords: A. Natural fibres; A. Biocomposite; B. Fibre deformation; Strain mapping