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Experimental Study of Moisture Effect on the Mechanical Behavior of Flax Fiber Reinforcement

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Abstract : The demand for bio-based materials in semi-structural and structural applications is constantly growing to conform to new environmental policies. Among them, Plant Fiber Reinforced Composites (PFRC) are attractive for the scientific community as well as the industrial world. Due to their relatively low densities and low environmental impact, vegetal fibers appear to be suitable as reinforcing materials for polymers. However, the major issue of plant fibers and PFRC in general is their hydrophilic behavior (high affinity to water molecules). Indeed, when absorbed, water causes fiber swelling and a loss of mechanical properties. Thus, the environmental loadings (moisture, temperature, UV) can strongly affect their mechanical properties and therefore play a critical role in the service life of PFRC. In order to analyze the influence of conditioning at relative humidity on the behavior of flax fiber reinforced composites, a preliminary study on flax fabrics has been conducted. The conditioning of the fabrics in different humid atmospheres made it possible to study the influence of the water content on the hygro-mechanical behavior of flax reinforcement through mechanical tensile tests. This work shows that increasing the relative humidity of the atmosphere induces an increase of the water content in the samples. It also brings up the significant influence of water content on the stiffness and elongation at break of the fabric, while no significant change of the breaking load is detected. Non-linear decrease of flax fabric rigidity and increase of its elongation at maximal force with the increase of water content are observed. It is concluded that water molecules act as a softening agent on flax fabrics. Two kinds of typical tensile curves are identified. Most of the tensile curves of samples show one unique linear region where the behavior appears to be linear prior to the first yarn failure. For some samples in which water content is between 2.7 % and 3.7 % (regardless the conditioning atmosphere), the emergence of a two-linear region behavior is pointed out. This phenomenon could be explained by local heterogeneities of water content which could induce premature local plasticity in some regions of the flax fabric sample behavior.

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