Influence of Compression Tilt Angle on the Elastic Properties of Single Fibers Identified From Transverse Compression Tests

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Both the societal demand and the EU policy expect renewable and environmentally friendly materials. This promotes an increased interest in plant fibers and their use in composites. Even though plants fibers have been used for thousands of years, knowledge on their mechanical properties is still lower than synthetic fibers that are juvenile in comparison. Up to now, their properties have been investigated under tensile tests. However, composite materials are often used in situations that require them to withstand forces in the transverse direction (the one; perpendicular to the fiber's orientation). Thus, the need for characterization of the fiber's transverse property is crucial. This need is also shared with synthetic fibers and monofilaments. Indeed, they have several applications in which transverse compression is important (e.g. ballistic cloth and cables). Only few devices and studies have been developed to analyze the transverse compressive behavior of single fibers, so far. It is well known that this test requires a good alignment and parallelism of the compressive platens. The influence of these parameters on the identified elastic properties have never been investigated as well as the parallelism defect tolerance never quantified. This is the main objective of the present study.

This communication will present numerical simulations and experimental results of the single fiber transverse compression test using a novel test device recently developed in our lab. This set-up is based on micro-mechatronic and vision systems (Figure 1). The present study is mainly focused on synthetic fibers such as PA11 monofilaments.

A sensitivity analysis is proposed to evaluate the influence of the tilt angle (i.e. the angle between the planes of the compressive platen). This is performed, at first, using a Finite Element model (Figure 2). Results are further compared with experimental results collected for different tilt angle values. Results show the very high sensitivity of the identified transverse modulus to this angle between the compressive platens, even for values below 1°. It is suggested to include this parameter in the models used to identify the transverse elastic properties to ensure an accurate estimation of this material property.

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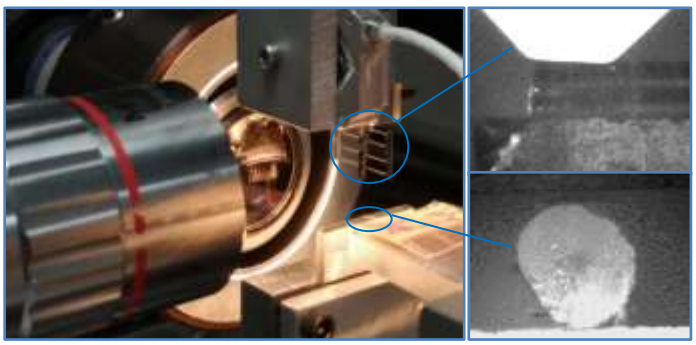

Figure 1 Experimental setup (left), fiber view (right) longitudinally (top) and transversally (down).

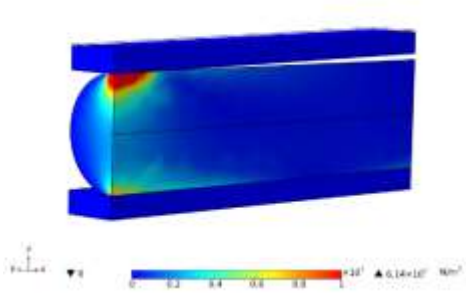

Figure 2. Finite element simulation (Von Mises stress) of a transverse compression test on an ideal fiber with a tilt angle between plates and the fiber's parallelism.