Non linear behavior of flax/epoxy unidirectional composite

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Plant-based reinforced polymer often present non linear behavior under tensile solicitation. It is clearly the case for flax fiber reinforcement for which a yield point separates the composite behavior in two regions. This is visible on experimental curves in articles that do not deal only with unidirectional reinforcement [1,2] but also with reinforcement by random mat of flax [3]. In a previous work [4] we proposed a viscolastoplastic model to study the non linear effects. The used material was made by epoxy resin and twisted yarn of flax as reinforcement. We identified eight parameters to correctly simulate the behavior of flax/epoxy UD in repetitive progressive loading, creep test and relaxation test at normal condition (room temperature, usual speed, normal humidity). The used parameters take into account viscoelastic and viscoplastic contributions. The first region of tensile curves is quasi-elastic and the second region is viscoelastoplastic. The model do not necessitated a reorientation parameter, but we observe contraction of the elastic domain during loading.

It is known that tensile speed [4], wetness [5], and temperature [6] impact the apparent behavior of flax fiber reinforced polymers. Low tensile speed increases identifiability of the viscous effects. Temperature and wetness decrease the material rigidity. In case of high tensile speed, high humidity, or high temperature – with three apparent regions (see fig. 2C in [4] and fig. 3 in [6]) - the behavior of tensile curve seem to be more general than previously described. In order to study this general behavior, we are studying flax/epoxy industrial unidirectional composite behavior. We decided to act on tensile speed and on the testing temperature to identify a new set of viscoelastoplastic parameters. We will present the first results in the International Workshop « Dynamic behavior of green composites ». The figure 1 clearly shows the difference in behavior when decrease the speed or increase the temperature. By modeling such an experimental behavior, we aim at confirming the previously studied behavior (what about its generality for flax fiber composite?), and we aim at exploring the origin of the third region by model analysis (is the stiffening correlated to microfibrill reorientation?).

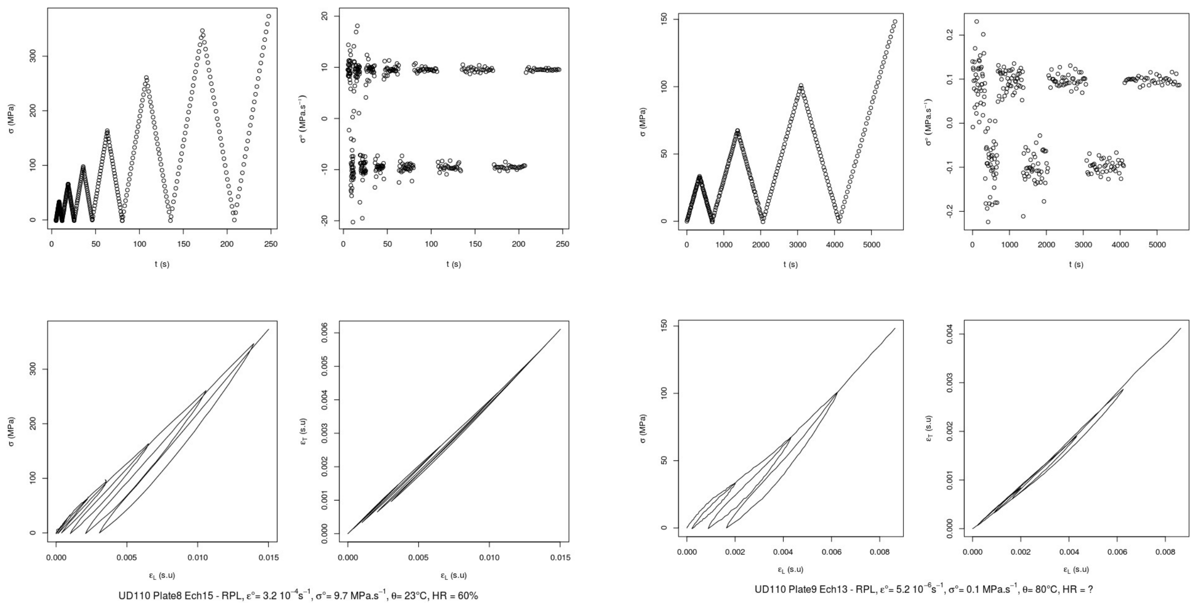

Fig. 1 Experimental tensile test at high speed and ambient temperature (left) and low speed and high temperature (right).

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