Investigating Non-elastic Effects during Compression of Fibre Reinforcements

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ABSTRACT

A wide variety of manufacturing processes have been developed to produce fibre-reinforced polymer composite articles. Many of these techniques require compression of the fibrous reinforcement to achieve the desired material composition and properties. To include this compression deformation in the simulation of composites manufacturing processes, a common approach in the literature has been to assume that the reinforcement deformation is non-linear elastic. However, previous research has demonstrated visco-elastic behaviour, as well as plastic deformation. More in-depth investigations have produced observations of stress relaxation and hysteresis, which are typical indicators of non-elastic deformation. These materials also respond differently if a thermoset (low viscosity) polymeric resin is introduced within the reinforcement structure, which is significant to a range of composites manufacturing processes.

A series of experiments were designed and carried out to further investigate these non-elastic effects, and to establish their relative importance. Specifically, the aim has been to determine the proportion of each type of deformation and its variation with respect to time, taking into consideration elastic recovery. Material behaviour following cyclic loading and unloading has been studied. The long-term goal of this work is the development of a comprehensive reinforcement deformation model, incorporating the different kinds of deformation observed. This will be important for improvement of composites manufacturing simulation processes.