Non-linear mechanical behaviour and bio-composite modelling of oil palm mesocarp fibres

ABSTRACT

Understanding the non-linear mechanical behaviour of oil palm mesocarp fibres (OPMF) is important for bio-composite application. The mechanical characterisation of this fibre is challenging due to the microstructure of the fibres consisting of silica bodies on the surface and cellular structures within the cross section. In this work, we proposed a constitutive material model for OPMF by including a stress-softening function into the large strain viscoelastic model. The model shows agreement with loading–unloading and stress relaxation tensile tests. The model was then used for micro-scale finite element modelling of the fibre–silica body–matrix (resin) interface to simulate sliding of a bio-composite material. A multi-particles model was also developed to check the effect of the constitutive model towards the mechanics of a bio-composite system. Modelling results suggested that under the micro-scale level (~50 μm), silica body plays a major role in improving the mechanical behaviour of the bio-composite system. On the other hand, under the macro-scale level (~0.18 mm), a single fibre model is sufficient to simulate a bio-composite multi-fibres material.

Keyword: Oil palm fibres; Viscoelasticity; Finite element analysis (FEA); Tensile testing