Progressive damage analysis of natural fiber composite laminates: A computational micromechanical perspective

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Natural fibre composites regarding their inherent environmental and performance advantages have become an alternative to environmentally harmful synthetic materials. These kinds of materials can be helpful in controlling pollution problems. Besides, having advantages like recycling benefits, potential cost saving, good dimensional stability and reduced tooling abrasion makes wood fibre-reinforced high-density composites an appropriate choice for usage in areas such as construction, automotive, interior decoration, and daily life [1, 2]. Nowadays, giant automotive makers like Mercedes Benz, BMW, Toyota and Ford widely use moulded sheets made of fibre mats to produce various components of their automobiles [3].

The damage modes of fibre-reinforced composites are vital constraints in their applications. Various damage modes have a significant effect on the behaviour and performance of these materials. Moreover, composites developed with natural fibres and matrix materials are mostly orthotropic and predicting their failure is even more difficult [4]. In spite of their distinctive assembly and appearance, adhesively bonded wood products such as Oriented strand board (OSB), plywood, and engineered structural lumber can be distinguished by their macrostructure as wood or adhesive.

In this work, a numerical method is used to evaluate the effect of micromechanical damage modes on the properties' degradation of wood fibre-reinforced composites. The cohesive zone model (CZM) and extended finite element method (XFEM) are used to study the effects of initiation and propagation of fibre-matrix debonding and matrix cracking in various RVEs (Representative Volume Elements).

Firstly, the damage behaviour of these RVEs is studied and the method is validated, then the mentioned method is used to evaluate the properties' degradation of these materials. The obtained results could be used to investigate the properties degradation of natural composite laminates in continuum damage mechanics.

References

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