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Numerical Analyses of Micro Hygro-Mechanical Behaviours of
Wood Fibre Reinforced Composites

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Abstract

In spite of their relatively low manufacturing costs and enhanced mechanical properties, wood fibre-reinforced composite materials have a number of drawbacks regarding the long-term durability. One of which, as commonly known, arises from the hygro-expansion subjected to moisture uptake in wetting-drying cycles. Various experimental studies have been performed to investigate the mechanical behaviours in multi-scale whereas much less attempts on simulation-based studies are published. This research is presented to simulate the hygro-mechanical behaviours of wood fibre-reinforced composites in microscopic scale. Hygro-expansion strains in orthotropic directions are accounted for. Weak formulation Finite Element Method for hygro-expansion of wood fibre constituent is developed and the algorithm is implemented using MATLAB. Variables in the model are domain dimensions, elastic constants and densities of both constituents, fibre weight fraction, hygro-expansion coefficients of wood fibre and relative humidity. The simulation results exhibits reasonable agreements with the experiments - sorption tests of wood fibre-polymer matrix composite from previous studies, and wood fibre-cement matrix composite from our experiments. This model aims to be a preliminary design tool for creating wood fibre-reinforced composites exposed to high relative humidity. Further studies can be done to investigate cracking behaviours under wetting-drying cycles.

Keywords: Wood Fibre-Reinforced Composites ; Hygro-Expansion ; Finite Element Method