Recent developments in multi-scale modelling of timber materials and structures

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**ABSTRACT**

Over the last two decades, mass timber construction has been gaining increasing popularity in residential applications, mainly in Europe and North America. In this respect, cross-laminated timber (CLT) is probably the most popular mass timber product normally used in floor slabs and shear walls of buildings. As CLT panels are light-weight structural elements with high stiffness and strength to bending, compression and shear, they are an economically competitive building system when compared to traditional materials, like concrete, masonry or steel.

In this work we review some recent developments in multi-scale modelling strategies adopted to capture the structural response of timber materials and structures. The material scales range from the wood cell-wall at the order of few nanometres up to the structural scale, at the order of meters. In order to couple these scales, a computational homogenisation scheme based on the volume averaging of the stress and strain fields over a representative volume element (RVE) of material is adopted. Periodic kinematical constraints are imposed on the RVE boundary domain. By adopting a bottom-up approach, the sequential homogenisation procedure allows us to compute the overall structural response of wood. As we are interested in improving the predictions of our computational multi-scale simulations, we follow a Genetic Algorithm-based optimisation technique to calibrate the micro-mechanical parameters. Finally, we present recent progress on the complex modelling of CLT buildings, where the mechanical interaction among adjacent CLT panels and the hysteretic behaviour of steel connectors play a crucial role to predict accurately the overall seismic response.

*Keywords*: Cross-laminated timber, multi-scale modelling, finite elements.