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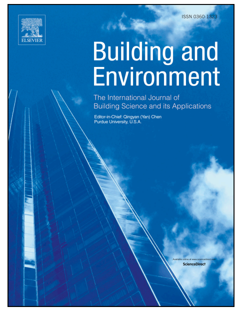

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Characterization of the coupled hygrothermal behavior of unfired clay masonries: Numerical and experimental aspects

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Abstract

Numerical and experimental methodologies are presented in order to evaluate thermal and moisture buffering properties of hygroscopic masonry walls composed of unfired clay bricks. An original full-scale instrumented wall is subjected to various transient scenarios on both faces, using a double climatic chamber device. This equipment allows a separated thermodynamic balance in the two rooms for the determination of heat and mass flows through the wall. The development of a coupled heat and mass transfer process implemented in the Cast3M finite element software is outlined as well. The material's input parameters for the model are first identified on samples at a decimeter scale. Among them, a continuous dependence law governing vapor permeability vs. moisture content is established, by exploiting the kinetics of sorption steps in both cubic and half-brick samples. Based on these experimental characterizations, all parameters are introduced for the simulation of a full-scale wall through different scenarios of hydric loading. Comparisons drawn between simulation and the experimental evolutions of moisture and temperature show a good accuracy at this scale. The moisture balance quantities derived in both cells are also verified, proving the model's effectiveness in terms of mass transfer simulation. Finally, the thermal effect of sorption heat is also discussed, experimentally as well as numerically. For realistic scenarios, it is shown to be limited to about 0.5 K.

Keywords: unfired clay bricks - coupled heat and mass transfer - experimental characterization - finite element model - double climatic chamber