Sandwich panels with high performance concrete thin plates at elevated temperatures: numerical studies
Performance of conventional load-carrying sandwich structures made of concrete can be improved by the use of high performance concrete (HPC) plates of thin sections (30 mm), linked by shear connectors ensuring the composite behaviour of the structure. This paper proposes the application of a coupled heat and mass transfer (HMT) model to HPC thin plates to study their behaviour at elevated temperatures, predicting temperature and pore pressure distributions. The same model was applied to a sandwich structure including thin plate, stiffening rib, and insulation layer. A last simulation concerned HMT modelling and elastic stress analysis with nonlinear temperature effects of a full size loaded sandwich wall, qualitatively assessing the location of critically stressed zones. Modelling output was compared to published experimental results. The model reproduced experimental temperature recordings satisfactorily, except phase changes of water at low heating rates. It was suggested that the function governing moisture evolution with temperature and pressure should be updated for HPC. Pore pressure was found critical for sandwich structures due their higher temperatures. Adding polypropylene (PP) fibres for pressure release is recommended. Stress analysis showed the stiffening rib assumes the major load-carrying role. The thin plate was found largely sensitive to heat, its thermal bowing restrained by shear connectors creating high localised tensile stresses. It was suggested to anchor the shear connectors in the ribs. Geometric discontinuities were also found critical; therefore separation of rib and plate is advised for hazardous situations such as fire events.

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