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INVESTIGATION OF CONSITUTIVE LAWS FOR MODELLING CONCRETE AT HIGH TEMPERATURE BY THE AID OF NEUTRON IMAGING

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When a structural element is exposed to high temperature, concrete is prone to spalling. The latter exposes the reinforcement and may lead to premature failure of the structural element putting at risk the safety of concrete structures. The evolution of moisture content is believed to be one of the processes directly related to this phenomenon. Numerical models found in literature [1] for studying the behavior of concrete at high temperature follow the theory of heat and mass transfer in porous media. The validation of these numerical models is usually based on experiments as in [2] measuring temperature and pressure inside a heated concrete specimen. However, pressure measurements are not always reliable since the pressure can be influenced by the sensors or by cracks.

In this study, the evolution of moisture content obtained from neutron imaging of high-performance concrete at high temperature [3] are compared with results from a numerical model implemented in the finite element code Cast3M. The water loss measured experimentally and the numerical results suggest that the commonly used constitutive laws for dehydration and water retention curves need to be reconsidered. The influence of these constitutive laws in the moisture migration is investigated. The dehydration constitutive law plays an important role on the dehydration front but has negligible effect on the moisture accumulation behind this front. In contrast, the water retention curves do not influence the dehydration front, but affect the quantity and location of water condensation. A parametric study on the role of the permeability is also presented. The implementation of the numerical model is done in the finite element code Cast3M. The solution of the system of equations is obtained by adopting a fully coupled monolithic approach which reduces the computational cost up to 30 times compared to the previous models in Cast3M.

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