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SALT DIFFUSION AND CRYSTALLIZATION IN MASONRY WALLS: A COMPARISON BETWEEN CHLORIDES AND SULPHATES

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Centuries of masonry construction in the majority of Countries have left a wide historical building-stock inheritance, often of extraordinary architecture and design. To conserve these structures it is more and more required to understand the deterioration processes caused by the environment. One of the major factors of degradation in masonry is salt crystallization. Salts can originate from numerous sources: in particular they can originate by infiltration of saline moisture from the soil.
In order to capture this phenomenon an accurate transient heat, air and moisture (HAM) transfer model in porous materials is essential, since the hygrothermal conditions strongly influence the salt precipitation. The numerical simulation of heat and moisture transport phenomena has been widely investigated and many models have been developed [1]-[3]. These kinds of models are highly non-linear, fully coupled and time dependent. Moreover, their extensions to embed salt diffusion and crystallization – see, for example, [4]-[8] – increase the computational demand. Starting from the results of these models, the prediction of stresses induced by salt crystallization can be performed, in order to evaluate the damage that may occur in masonry structures. Some developments in this direction can be found in [4], [9].

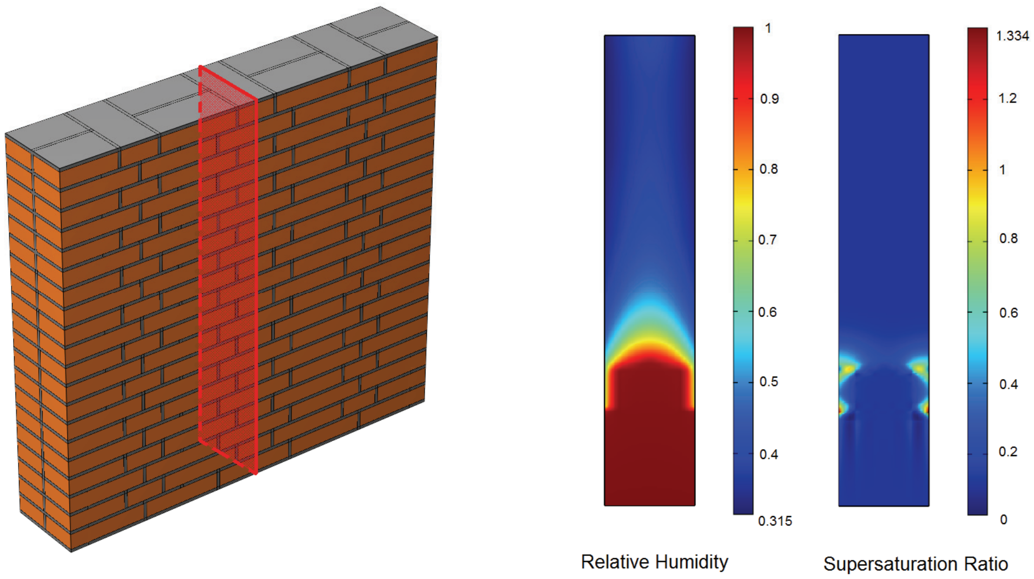

Figure 1.Uptake test of sodium chloride solution: maps of relative humidity and supersaturation ratio.

In this work, solution uptake tests in masonry walls exposed to real weather conditions in non-isothermal and non-hygral regime are simulated (Figure 1). The masonry is modelled as a homogeneous equivalent brick and the fully coupled multiphase model for hygrothermal analysis and prediction of salt diffusion and crystallization – presented in [4] for sodium chloride solutions and extended in [5] for sodium sulphate solutions – is implemented. The model consists of three balance equations referred to the masonry Representative Elementary Volume (REV) – moisture mass conservation, salt mass conservation and energy conservation – together with evolution equations: one describing salt precipitation/dissolution in the case of sodium chloride or two describing salt crystallization/dissolution and hydration/dehydration kinetics if sodium suphate is considered. Relative humidity, temperature, mass fraction of the dissolved salt and the concentration of precipitated salts are assumed as indipendent variables. Time-dependent simulations are carried out to describe the same masonry wall, with the same boundary conditions, varying the kind of salt in aqueous solution considered. In particular, the capillary risings of sodium chloride and sodium sulphate solutions are considered and compared, with special emphasis for the stresses induced by salt crystallization.

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