

The Use of COMSOL Multiphysics® Software to Explore Flooding and Rising Dampness Problems Related to Cultural Heritage

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Abstract

In The Netherlands rising dampness problems due to flooding of rivers and high groundwater levels form an essential threat for monumental buildings and heritage. A number of cases exists where rising dampness problems lead to the deterioration of wall finishes but also of valuable wall paintings in churches and castles.

To explore the problem and to look for solutions like drying regimes, measures like drainage etc. a physical model was needed to describe wetting and drying of masonry and other porous media by physical phenomena like capillary suction, rising damp, drying and evaporation. In COMSOL Multiphysics® software, a model was built making use of equations for the capillary pressure in the vapour and liquid regime.

The model was used to describe the rising dampness problems of a monumental chapel in Lemiers, The Netherlands. In 1978 an artist, Hans Truijen (1928-2005) has painted the internal walls.

Figure 1: Cobra-like wall paintings by Hans Truijen

These paintings in the chapel suffer from an ever faster developing decay. In particular, the lowest parts of the walls and paintings are badly damaged. In some places whole sections of paintings disappeared. Rising dampness in the walls has entrained salts, the drying of these form crystals, which have up to 80 times the volume of salts in the solute state. By varying relative humidities these salts are alternately in solution and crystallize afterwards. This phenomenon expresses the stucco and the already overworked paint of the wall.

For several years, measurements at different places were executed in the chapel: Temperature and relative humidity measurements inside and outside the chapel, surface temperature and moisture content measurements at different places of the wall were executed. COMSOL was used to physically describe the problem and evaluate possible solutions.

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Figures used in the abstract



Figure 1: Figure 1: Cobra like wall paintings by Hans Truijen.



Figure 2



Figure 3



Figure 4