BUILD SIMUL
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Numerical multi-physical approach for the assessment of coupled heat and moisture transfer combined with people movements in historical buildings

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Abstract

Air quality, temperature variations and humidity must be controlled in historical buildings in order to avoid hazards for cultural property and in some cases also for operators and visitors. Too many variations of any of these three parameters over time, can easily accelerate the aging process of the building materials as well as rare objects and artefacts. In cultural heritage, related indoor microclimatic condition control is fundamental for appropriate preventive conservation measures. A transient simulation model, for coupled heat and mass-moisture transfer, taking into account archivist and general public movements, combined with the related sensible and latent heat released to the ambient, is provided. The proposed method is based on the indirect approach to the numerical simulation of solid object movements in a fluid combined with heat, moisture flow phenomena and multi-physical conditions. Our method can be a useful tool for the evaluation of: indoor environment and air quality, that play an important role in guaranteeing that the building provide optimal conditions with regard to the appropriate use classifications (in historical buildings conservation of artworks plays a major role); the best compromise between people working and visitor comfort and temperature, relative humidity, presence of gases and/or permitted concentration levels for conservation and maintenance of works of art; conditioning and ventilation plant solutions; compliance with regulations and standards ensuring that all the refurbishment actions must comply with national and international indications for historical buildings (in particular museums, libraries, archives, rare book and manuscript collections etc.) protection and preventive conservation of works of art in them. Transient simulation results obtained are in good agreement with the experimental data collected through a monitoring campaign on microclimatic conditions inside the 18th century Palatina Library in Parma (Italy) i.e. our case study.

Keywords

transient simulation,
CFD-FEM,
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1 Introduction

The utilization of humidification and dehumidification processes provided by heating, ventilation, air conditioning (HVAC) plants usually increases the energy consumption of buildings combined with moisture control and efficient ventilation systems (Kohonen 1984; Gaur and Bansal 2002). Indoor climatic conditions of a building are the result of indoor heat and mass flow inside and between the surrounding ambient, the external environment and the building itself. Heat and moisture transport problems are fundamental for building materials and component durability, but also for functionality of internal zones (Tariku et al. 2010). In particular, these problems have become crucial for historical buildings, for which indoor air quality, ventilation and thermal conditions are important for protecting the moisture sensitive materials from variations in their equilibrium moisture content and ensuring cultural heritage conservation and maintenance. It is well known that most of the materials used for sculptures, plaster work, paintings, carvings, rare books and manuscripts have a moisture content at the equilibrium level corresponding to the relative

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