Modeling of Active Infrared Thermography for Defect Detection in Concrete Structures

S. Carcangiu[1], B. Cannas[1], G. Concu[2], N. Trulli[3]

[1]Department of Electric and Electronic Engineering, University of Cagliari, Cagliari, Italy
[2]Department of Civil Engineering, Environmental and Architecture, University of Cagliari, Cagliari, Italy
[3]Department of Architecture and Planning, University of Sassari, Alghero, Italy

Abstract

Building preservation and restoration is a complex problem to deal with, especially when concerning building of historical relevance. The evaluation of a structure real state shouldn't interfere with the condition and the functionality of the building, and should possibly involve limited costs. In the field of assessment methodologies, particular importance is given to developments of Non-Destructive Techniques (NDT) that aspire to achieve the higher number of information about materials and structures without altering their condition, for example by extracting samples. Most of the NDT for structural element characterization, like ultrasonic, magnetic field and eddy current methods, are mainly suited for the detection of defects at depths between 5 and 100 cm and they have two significant drawbacks: they need physical contact to the tested object and they generate images slowly by scanning. Infrared Thermography, also known as thermal inspection or infrared (IR) imaging, is a fast and remote method and it is becoming more widely used along with other NDT [1]. In fact, it is used for the non contact inspection of materials and it is characterized by the use of thermal and infrared sensors in order to visualize thermal surface contrast after a thermal excitation by flash or halogen lamps. Furthermore, the infrared thermography methods, with a selective heating of the surface under investigation, permit to detect and to characterize the inhomogeneities in concrete and masonry structures in the near surface region up to a depth of about 10 cm [2]. Therefore, modelling of the thermal phenomena which occur during and after thermal excitation of structures is necessary. In this paper the finite element method is used to simulate the heat transfer process induced by some halogen lamps in a 3D model. To validate the model, experimental measurements have been carried out on a concrete structure with an inside cavity. The wall used as test is 90 cm wide, 62 cm high and 38 cm thick. Using an empty box of polystyrene, a macro-cavity sized 20 × 38 × 14 cm3 has been realized and assumed as a known anomaly. Moreover further defects have been inserted in the near surface of the structure at different depth, as shown in Figure 1. The surface of the structure is excited using two halogen lamps with a power of 450 W. In order to study the influences of heat conduction, convection and radiation (surface to surface and surface to ambient) on the lateral heat flow through the defect, simulations will be reported in the full paper for two cases: in vacuum and in air.

Reference

[1] X. Maldague. Theory and Practice of Infrared Technology for Non destructive Testing, Wiley, New York, 2001.
[2] Ch. Maierhofer et al., "Application of impulse thermography for non-destructive assessment of concrete structures", Cement & Concrete Composites, Vol. 28, pp. 393-401, 2006.

Figures used in the abstract

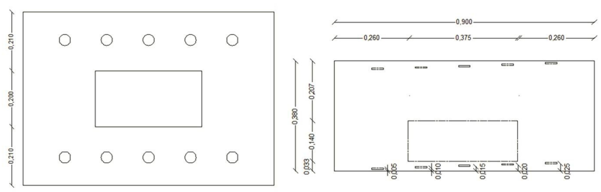

Figure 1: Front view and the horizontal section of the concrete structure under test (all the dimensions are in m).