Measurement of building materials thermal properties in transient regime by IR thermography

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Abstract

A testing procedure is presented to obtain thermal conductivity of porous building materials in steady state. This approach is particularly useful to analyze experimentally the differentiate local ageing of the material as in the case it is due to weathering of the exposed surfaces.

1. Introduction

Autoclaved Aerated Concrete (*AAC*) is a light-weight construction material utilized in contemporary buildings. This material is very attractive because of its low density and thermal and breathing characteristics [1,2]. *AAC* is particularly effective, as it improves thermal performances (increased thermal insulation) while permitting a moderate transpiration of the envelope. The study is focused on the determination of the thermal properties of *AAC*, which is a highly-porous material. The study is also conducted to monitor the changes in the thermophysical properties of the aged *AAC* samples. A considerable decrease in the mechanical properties is expected for AAC saturated with water for some days [1,4]. For this purpose, ultrasonic pulse velocity (*UPV*) [5,6] and thermal diffusivity measurements were used in a previous work, for both fresh and water-aged AAC samples [7]. The correlation between these measurements and the deterioration of the water-aged samples was not well established. One hypothesis is that the ageing acted only on the surface of the material, while the measured properties were averaged on the bulk material. This average value is thought to mask the small variations localized on the surface. On this purpose a steady state analysis of the thermal conductivity is proposed here to evaluate if a variation of local thermal conductivity, from the surface to the inner part of the sample exists.

2. Materials and Methods

A cubic sample of AAC is sandwiched between two thermoelectric devices (peltier cells). One cell works cooling one side of the sample, the other heats the opposite side. After a certain time, the two devices works in steady regime and the amount of heat they sink and source respectively is proportional to the electric current that flows through them. The temperature reached on the two side of the sample depends on the heat flux sunk and sourced, and on the temperature of the opposite side of the peltier cell. This surface is in contact with a thermal bath, where the heat sunk (or sourced) from/to the sample is on its turn sourced (or sunk). Fig. 1. Shows the experimetas set up for thermal conductivity measurements.

In steady conditions with adiabatic lateral conditions and in case the conductivity of the macroscopically homogeneous material is constant, the temperature profile from the hot to the cold side of the sample must change linearly:

$$T_{hot} - T_{cold} = \frac{L}{\lambda} q \qquad (1)$$

where T_{hot} and T_{cold} are the temperature on the hot/cold side, L the sample thickness, λ the thermal conductivity and q the heat flux.

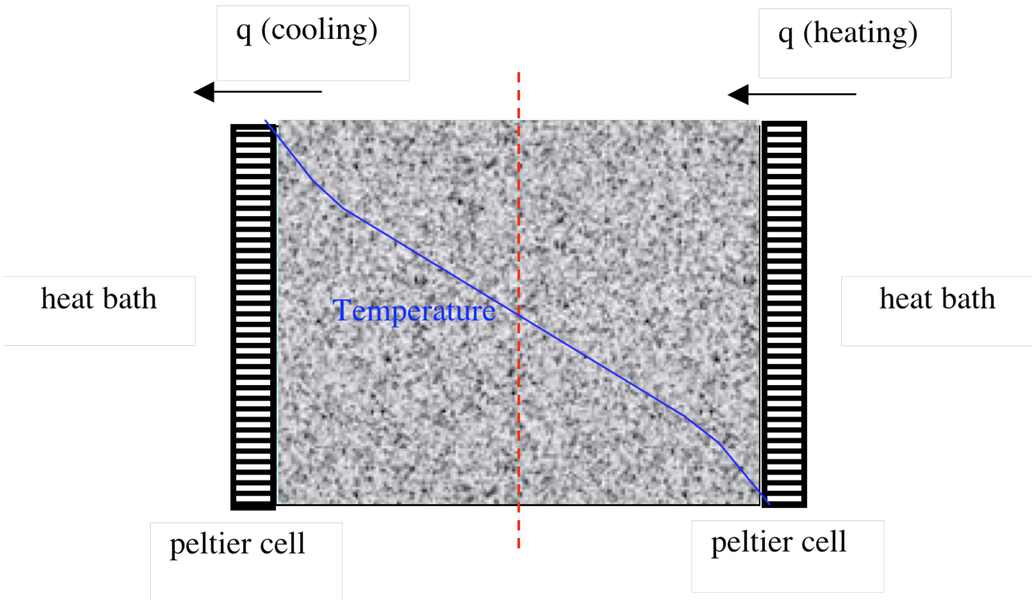

Fig. 1. *scheme of the experimental set up*

The problem of the lateral adiabatic conditions is addressed in such a way, that the average temperature of the sample is nearly the room temperature. Of course, this minimize the heat exchange with the environment, but a divergence from the linear temperature profile is expected close to the surface in contact with the two peltier cells. Because of the symmetry of the testing apparatus an opposite but equal divergence will occur for homogeneous materials.

The processing technique at first recovers the average conductivity by means of a linear best fitting on experimental data coming from the central part of the temperature side profile.

The second step is the comparison of the temperature side profiles of the "warm" side (where the surface is heated) and the opposite of the "cold" side (where the surface is cooled). In case the ageing due to the material exposure to the water, induces thermal properties differences on just one side. This approach allows to verify such a conditions.

Test on different AAC samples: "as it is", aged for 6 days and aged for 30 days has been performed and results presented.

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