DESIGN AND REALIZATION OF AN EXPERIMENTAL APPARATUS BASED ON HOT PLATE CONCEPT FOR MEASURE OF THERMAL RESISTANCE OF BUILDING INSULATING MATERIALS

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ABSTRACT

Building insulating materials are the key in designing and constructing energy saving buildings. Accurate characterization of materials and their assembly configuration is needed to evaluate influence of different solutions on buildings performance and moreover it is a necessary step to guide industry development phase to the proper product design.

Among the different instruments for the measure of thermal resistance of plane elements, guarded hot plate method represents a good trade-off between procedure simplicity and results reliability. It is commonly used for building insulating materials in compliance with technical standard UNI EN 12664:2002 e UNI EN 12667:2002 to validate building elements performance, even for CE marking. Instruments architecture requires an active guard area surrounding hot plate and refrigeration system for external surface of the sample, so resulting in an expensive solution for realization and use.

Present work proposes a thermal resistance measurement system, derived from hot plate concept, which simplify some building features without compromising its reliability. The purpose is to provide an instrument capable to guide industry development toward certification during building materials development phase, keeping cost down and with good reliability, though not substituting certification itself.

System design is described including choice of materials, temperature measurement instrumentation and temperature probes arrangement, focusing on technical issues found during assembling and strategies taken to ride over them.

Moreover a comparison with the norm prescriptions is included to pointing out differences and similarities, justifying the simplification of the proposed architecture compared to that indicated in the standard, in the perspective to achieve good performance reducing cost and time-consuming operations required for final certification procedure.

Main changes from the norm are the vertical position of the hot plate, the fourfold increase of the hot surface and the consequent increase of temperature measure points, the change from active to passive guard area and finally the removal of the refrigerating element, substituted by ambient air.

Calibration procedures of the whole system are described focusing on temperature measurement and analysis of thermal losses which affect the accuracy of the measure of thermal fluxes through the sample and then the value of measured thermal resistance.

The system allows to measure thermal resistance of non-homogeneous wall samples, like framed panels, unventilated air layers or glass blocks, taking into account of the thermal bridges effects which can significantly influence thermal resistance of the building element for this type of assembly configuration.

Some preliminary results obtained by the system are presented concerning measures on homogeneous expanded polystyrene panels and a sample glass block wall. Proposed system is particularly suitable for the characterization of glass block wall due to the size of its surface, its vertically position and the number of temperature probes.

The thermal resistance values obtained allow to validate the system behaviour, pointing out the stability and accuracy of the results and their good agreement with those obtained with the standard compliance procedure.