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ABSTRACT

PRESENTATION

PAPER

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INFRARED THERMOGRAPHY FOR MEASURING SURFACE HEAT FLUX THROUGH BUILDING ENVELOPE

Transmission heat losses are a decisive aspect in the assessment of the overall energy efficiency of buildings. These heat losses can be determined by numerical calculations, in the laboratory or in-situ. Numerical analysis and laboratory techniques can be used if the element layers and their thermal properties are known; if this is not the case, in-situ methods should be used. There are different techniques to determine the transmission heat losses in-situ: by direct measurement of the heat flow of the elements on the building envelope (Heat Flow Meter method or HFM) or by measuring certain parameters that can be used to approximate the heat transfer across the surface under investigation (Infrared Thermography or IRT method).

In using the IRT method for measuring heat flux through building envelope, the total heat flux is divided into a radiative and a convective part. The radiative flux is then determined according to the Stefan-Boltzmann law, and the surface temperature and the apparent reflected temperature are measured with the infrared camera; the emissivity of the surface should be determined before starting the measurement. The convective heat flux is determined by the combined effect of natural and forced convection using analytical expressions from the literature. For an accurate approximation of the total heat flux, it is crucial to understand all the parameters that determine the heat exchange between the environment and the investigated surface. This paper examines the theoretical and practical foundations of the IRT method and its application to overcome these challenges, as well as the application of these methods to real measurements in the laboratory.

One of the main applications of the IRT in building physics is the identification of thermal anomalies such as thermal bridges. The IRT method in determining heat flux through building envelope offers unique advantages over the HFM as it allows researchers to visualize and quantify heat flow through building elements on a much larger scale. With the IRT method, it is possible to determine not only the heat flow, but also its deviation across the surface under investigation. This can be done by measuring the surface temperature on a much larger area compared to the area of the heat flux sensor. If the reflected temperature is measured at more than one point on the surface, the effects of the environment on the surface under investigation can also be recorded in more detail.

This study compares the HFM and IRT methods for determining surface heat flux densities on three different wall elements in the laboratory. The wall samples are concrete wall without insulation and with internal/external thermal insulation. The test specimens are mounted in a chamber in which the temperature, relative humidity and wind speed of the air inside the chamber, i.e. the outdoor air, can be controlled. The IRT and HFM apparatus is installed on the side facing the laboratory, i.e. the indoor air. The test is carried out over a period of approximately 7 days to take into account the influence of the thermal mass of the walls on the measured/estimated heat flux densities.

The main objective of this measurement is to determine the effects of the individual parameters: surface temperature, reflected temperature, indoor and outdoor air temperature, surface heat transfer coefficient (convection coefficient) and surface emissivity. The data analysis has shown that the following parameters influence the heat flux densities at the surface: Air flow, surface temperature and reflected temperature. For walls with external insulation, where the heat flux densities are minimal (close to zero), the effect of the surface temperature measured with the infrared camera is significant and the deviation of the heat flux is greater than the mean value of the heat flux density. For elements without and with external thermal insulation the IRT method gives a good approximation of the heat flux density as compared to the HFM method results.