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Experimental data set for validation of heat, air and moisture transport models of building envelopes

Tadiwos Zerihun Desta, Jelle Langmans, Staf Roels*

Division of Building Physics, Katholieke Universiteit Leuven, Kasteelpark Arenberg 40, B-3001 Leuven, Belgium

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ABSTRACT

This paper reports experimental studies on heat, air and moisture (HAM) transfer through a full scale light weight building envelope wall under real atmospheric boundary conditions. The main objective of the article is to generate informative data so that it can be used for numerical validation of HAM models. The considered wall is a multilayered structure built up from outside to inside of external board, vented cavity, fibreboard sheathing, mineral wool between wooden studs and interior finishing. The global wall has a surface area of (1.80×2.68) m^2; and is subdivided into three vertical parts. The parts differ from each other by the applied interior finishing. Between the different layers of each part and on the surfaces of the wall humidity, temperature and heat flux sensors are placed in a 3D matrix. At the outer surface of the wall, the applied sheathing is a bituminous wood board. In the board nine removable specimens are included. By regularly weighing the fibreboard samples, their moisture content could be quantified. Using data collected over a total time span of about two years, insight about the hygrothermal behaviour of the different envelope parts is obtained and at the same time a well-documented data set is generated that can be used for hygrothermal envelope model validation purposes.

1. Introduction

Nowadays building designs need to fulfil with criteria of energy efficiency, minimum environmental impact and provide healthy and safe condition for building occupants. Light weight constructions are becoming a promising alternative in attaining the imposed criteria even in countries with a masonry tradition. Moreover the ease to incorporate a thick insulation layer between the wooden studs makes light weight buildings relatively simple to build, sustainable and renewable. But while high thermal performances are easily achievable, such constructions are susceptible for moisture-related structural deteriorations [1]. Moreover excess moisture can lead to the growth of pathogenic moulds and reduce the esthetical appearance of buildings [2]. In order to attain optimum performance, numerical models have been developed to simulate the hygrothermal response of building envelopes. These hygrothermal building envelope simulation tools (often referred to as Heat, Air and Moisture (HAM) models) evolved from the Glaser-method, a one-dimensional hand calculation method for vapour diffusion through insulated components [3,4]. Through the years models that incorporate heat and moisture capacity, liquid water and air transport, two- and three-dimensional aspects and different moisture sources such as wind driven rain, rising damp, initial moisture, interstitial and surface condensation have been developed [5–7]. Several of these HAM-models are nowadays commercially available for practitioners in the field and are increasingly used for analysing the heat and moisture behaviour of building components. Although HAM models are excellent engineering tools to optimise and analyse thermal and moisture performance of buildings and building components, care need to be taken on their use. For example incorrectly defined boundary conditions and material properties can lead to erroneous results [8]. Furthermore the models need to be validated under different realistic scenarios before the predictions are credible.

An important effort to standardise HAM-modelling procedures was made by the EU-initiated HAMSTAD-project (Heat, Air and Moisture Standards Development) [9]. Benchmark cases were used for model validation. The cases have been selected in such a way that various materials, transport mechanisms and climatic boundary conditions were covered [10]. The validation, though, relied only on numerical inter-modal comparisons or problems with simple analytic solutions since accurate and well-documented experimental data are scarce. In the framework of IEA ECBCS Annex 41 a transient heat and moisture experiment on a porous building material was performed for benchmarking numerical models with respect to hygroscopic loading [11]. This kind of well-controlled

* Corresponding author. Tel.: +32 16 321349; fax: +32 16 321980.
E-mail address: staf.roels@bwk.kuleuven.be (S. Roels).

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