Moisture Analysis of Building Envelopes

Background description

Moisture in buildings has been given more and more attention the latest decade. Not only old houses with water leaks but also new houses have shown damages caused by moisture accumulation within building envelopes, see e.g. [1].

According to the Danish Building Regulations, [2] and the corresponding guidelines [3], buildings have to be secured against moisture accumulation due to moisture transport from internal air and moisture absorbed from the external ground.

The recommended approach to verify risk-free exterior building envelopes with respect to moisture transport from internal air is to use a steady-state diffusion model, see e.g. [4] and [5]. In this diffusion model, temperature and humidity curves are calculated using monthly averaged data for interior and exterior temperature and humidity as input. See also [6]

The advantage of the steady-state diffusion model from [4] is that it is simple and easy to use. A calculation for a single building envelope only involves a few input data and the output can give an indication whether or not the building envelope could course any moisture risk.

An alternative approach is to perform a more accurate analysis using a dynamic model like e.g. [8]. A dynamic analysis has the advantage that it can be used to simulate temperature and humidity transport and can take more factors into account. The drawback is that these models are more complex and their usage therefore could be somewhat limited.

Data measurements for temperature and humidity through an exterior building envelope can be performed as an alternative or a supplement to calculations. Life data measurements open up for a variety of uses like moisture risk monitoring, educational and research purposes e.g. analysis of averaged and peak data or to verify the diffusion model given in [4].

Data sets could be collected using a data logger connected to temperature and humidity transducers e.g. in different depths through a wall, each measuring a new data set in a given time interval e.g. every 5 minute. A server hosting a database receives data from the data logger and thereby opens up for specific client computers to fetch the data, see e.g. [9]. A challenge in monitoring and collecting moisture data within a building envelope is to ensure reliable and accurate data.

Today, only a few databases collecting data from a building envelope are available but in near future VIA University College and partners are expected to build in transducers and collect and send data from renovation and new construction projects. One of the purposes for these projects will be to collect and present data for different kinds of markers like moisture, energy usage, indoor climate and hopefully to provide a quantity of data from a number of different building envelopes.

Collecting data from various building envelopes e.g. for educational and research purpose would involve specific knowledge of each database which among other things could vary both with respect to hosting and with respect to type and structure of database. The differences in the way to fetch the data could make it difficult for a single client application to collect and compare data coming from different sources.

Main purpose

The main purpose is to test for validity and usability of the steady-state diffusion model given in DS/EN ISO 13788, see [4]

Problem formulation

The validity of the steady-state diffusion model [4] will be tested comparing measured data with output from an application following the steady-state diffusion model [4].

The usability of the steady-state diffusion model [4] will be tested analysing averaged, peak values and complete data sets for measured data for buildings exposed to a natural climate and usage. Measured data will be compared with output from an application following the steady-state diffusion model [4], output from steady-state calculations using shorter time interval and an application using heat and moisture transport simulations.

Questions to be answered are the following

- Does the theory apply to real life scenarios?
- Is the steady-state diffusion model [4] useful as a basis for moisture documentation?
- Is the steady-state diffusion model [4] useful as an alternative to more complex dynamic models?
- Can the steady-state diffusion model [4] model be translated into a simple and easy-to-use application?
- How to get reliable measured data using transducers and data loggers?

Subprojects and related projects

In order to test for validity and usability for the steady-state diffusion model [4] data for a quantity of building envelopes and in a longer time period needs to be available. This project functions as a frame project for a number of subprojects and also rely on data and conclusions from other external projects. Some of which have already started.

November 2012 the following projects and status were the following:

Project #1: Moisture Analysis – An application for steady-state diffusion analysis
Purpose: The purpose has been to develop a system 1) directly following DS/EN ISO 13788, the Danish Building Regulations and the corresponding guidelines and 2) a system for moisture analysis as a sequence of calculations in a specified time interval.
Status: Application released October 2011 for download, see [6]. About 350 Danish and international students at Constructions Architect and Civil Engineering in Horsens Denmark have used and tested the application and some bugs and inappropriateness's have been found and fixed. Project Description in Danish is available here [7]. Documentation wise a few Java classes need some extra code description to finish up the help files for the developer. Some extra work is needed for advertisement in order to let the application be a well-known standard for moisture documentation e.g. in connection to applying for a building permit.

Project #2: Analysis of moisture and temperature data from an exterior wall, Kirkestræde 47 Nexø
Purpose: The purpose is testing the usability for the steady-state diffusion model in DS/EN ISO 13788 for a given exterior wall exposed to normal usage and climate. The project also

functions as a pilot project which will lead to recommendations for ensuring data validity to future projects about moisture data collection.

Status: Data has been collected since March 2011 and made available as charts and for download [9]. Project description and charts from measurements and calculation have been produced. Project Description in Danish is available here [10]. Results have shown irregularities in data and a conclusion is that the measured values are too inaccurate due to heat produced by the transducers. A written report and conclusion is not yet present.

Project #3: How to get reliable moisture and temperature data measurement within a building envelope

Purpose: The purpose is present a plan for transducers, data loggers and data collections in order to minimize sources of error and uncertainties

Status: Not started.

Project #4: Moisture Data Collector

Purpose: The purpose is to create an IT system that can collect moisture data for various building envelopes in a uniform and generic way.

Status: Project plan created. Not started.

References

[1] SBi Guidelines 216 - Fugt i bygninger, Erik Brandt et. al., Statens Byggeforskningsinstitut, 2009 (in Danish)

[2] Building Regulations 2010, The Danish Ministry of Economic and Business Affairs and Danish Enterprise and Construction Authority, http://www.ebst.dk/file/155699/BR10_ENGLISH.pdf

[3] SBi Guidelines 224 – Guidelines on Building Regulations 2008, Birgitte Dela Stang (ed.), Statens Byggeforskningsinstitut, 2008

[4] DS/EN ISO 13788:2001 – Hygrothermal performance of building components and building elements – Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation methods

[5] Moisture in Buildings, Steffen Vissing Andersen, VIA University College, Campus Horsens, 2009, http://sva.it-engineering.dk/Course/Moisture/Documents/Moisture_in_Buildings.pdf

[6] MoistureAnalysis – An application for steady-state diffusion analysis. http://sva.ict-engineering.dk/MoistureAnalysis/

[7] MoistureAnalysis – An application for steady-state diffusion analysis, Project Description (in Danish). http://sva.ict-engineering.dk/MoistureAnalysis/DK/Projektbeskrivelse/

[8] MATCH BOX, Simulation of Moisture Transport in Building Constructions, http://www.match-box.dk/dk/index.htm

[9] Moisture and temperature measurements for demonstration house Kirkestræde 47 Nexø (in Danish) http://demohouse.eu/fugt/

[10] Moisture and temperature measurements for demonstration house Kirkestræde 47 Nexø, Project Description (in Danish) http://sva.ict-engineering.dk/Moisture/Nexo/