Effect of façade impregnation on feasibility of capillary active thermal internal insulation for a historic dormitory – A hygrothermal simulation study

Internal insulation of external walls is known to create moisture performance challenges due to increased moisture levels and condensation risk on the cold side of the insulation. Capillary active/hydrophilic insulations have been introduced to solve these moisture problems, since they are able to transport liquid moisture to the inner surface and enable it to dry. Experience with this insulation type is rare in Denmark. In hygrothermal 1D computer simulations, several more or less capillary active insulation systems (AAC, calcium silicate, IQ-Therm) in various thicknesses (30–150 mm) have been tested for their hygrothermal performance. The original construction was a 228 mm solid brick masonry wall in a Copenhagen historic dormitory. All simulated systems showed critical relative humidity values above 80% and high risk of mould growth behind the insulation and some also on the interior surface. A moisture safe construction was only achieved when exterior façade impregnation shielding against driving rain was added. The best system showed acceptable relative humidity values both behind the insulation and on the interior surface, a significant increase in minimum temperature on the interior surface, and a reduction of heat loss through the external wall by 85%. The solely application of impregnation also resulted in a moisture safe solution with significant improvements in all parameters and heat loss reduction by 45%. The main conclusion is that capillary active insulation may not be feasible on solid bare masonry walls without additional driving rain protecting especially in case of multi-storey buildings with thin walls in high precipitation areas.
In 2012 Køge Boligselskab built 9 building blocks totalling 126 passive house apartments. Their monitored space heating demand (SHD) has been a lot higher than the passive house requirements. The aim of this study was to identify why, and how it relates to indoor environment and occupant behaviour. The SHD and indoor environment was analysed and corrected and by performing a statistical analysis, different parameters’ influence on SHD was determined. By simulating an apartment block, the effect of internal heat transfers between the apartments was determined. Furthermore, simulations were used to evaluate how the SHD was affected by different patterns of occupant behaviour. The monitoring indicated problems with overheating. However, the analysis suggested that the occupants actively chose these high temperatures. Simulations showed that internal heat flows could be up to 11.7 kWh/(m²a) per apartment. Furthermore, the results suggested that the indoor temperatures, weather conditions and occupants’ window opening could explain the higher SHD.

Using measured indoor environment parameters for calibration of building simulation model- a passive house case study

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics, Technical University of Denmark
Contributors: Paliouras, P., Matzafiras, N., Peuhkuri, R. H., Kolarik, J.
Number of pages: 6
Pages: 1227-1232
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Energy Procedia
Volume: 78
ISSN (Print): 1876-6102
Ratings:
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.92 SJR 0.378 SNIP 0.481
Original language: English
Electronic versions:
Using_measured_indoor_environment.pdf
DOI: 10.1016/j.egypro.2015.11.209
Chaetomium and Stachybotrys in water-damaged buildings

Fungal growth occurs when parts of the building envelope get very wet due to unfortunate combinations of factors, e.g., thermal bridges/lack of ventilation, shoddy foundations/flooding or leaks in build-in pipes. Chaetomium and Stachybotrys are not as abundant as Penicillium and Aspergillus (Table 1), however, they may produce volatiles and microparticles that can cause health problems. They are common in wet walls constructed of wood fibre board (OSB/plywood) and gypsum board.

Investigation of the Indoor Environment in a Passive House Apartment Building Heated by Ventilation Air

Experience has shown that appropriate design of very low energy dwellings can be a large challenge and that the final design may result in insufficient heating in winter and overheating in summer. The 126 certified Passive House apartments (Ravnsborghusene) in Køge, Denmark are a low energy building project finished medio 2012. The design challenge was met with a concept of air heating that is individually controlled in every room. It also applies external solar shading. This study used indoor climate measurements and dynamic simulations in one of these apartment buildings to evaluate thermal comfort and the performance of the air heating system and solar shading. Thermal comfort category B according to ISO 7730 was obtained in the building during field measurements, indicating that the air heating system was able to maintain comfort conditions in winter, when the outdoor temperature had been unusual low for a longer period. The dynamic simulations also indicated that air heating during winter can provide a comfortable thermal environment. Dynamic simulations also demonstrated that during summer, apartments with automatic external solar screens had no serious overheating, whereas in apartments with south oriented windows, static shadings by the balcony overhangs and low ventilation rates, resulted in excessive hours of overheating.
Measurement of water vapour transport through a porous non-hygrosopic material in a temperature gradient

This was an experiment to identify the driving potential for water vapour diffusion through porous materials in a temperature gradient. The specimen of mineral fibre insulation was placed between a space with controlled temperature and relative humidity and a space with a controlled, higher temperature, and a measured but not controlled relative humidity (RH). This assembly was allowed to reach equilibrium with no vapour movement between the spaces, as tested by a constant RH on each side and by zero flux of water vapour measured in the cold side chamber. The RH and temperature values were converted to partial vapour pressure and to vapour concentration in g/m³. The concentrations proved to be more equal on either side of the specimen than the partial vapour pressures. This supports an argument that it is concentration difference that drives diffusion of gases. Isothermal diffusion cannot be tested experimentally in this way, but it is reasonable to assume that concentration is the driving potential. The close equality of the concentrations makes it unnecessary to invoke temperature difference as a third possible potential for driving diffusion.

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Construction Materials, Section for Indoor Environment, Danish Technological Institute
Contributors: Hansen, T., Padfield, T., Hansen, K. K., Peuhkuri, R. H.
Pages: 1045-1052
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 10th Nordic Symposium on Building Physics: Nsb 2014
Publisher: Lund University
Editors: Arfvidsson, J., Harderup, L., Kumlin, A., Rosencrantz, B.
Article number: 130
Keywords: Diffusion, Potential Partial vapour pressure, Vapour concentration, Temperature gradient, Porous, Experimental
Electronic versions:
hansen_moisture_transport_NSB14.pdf
URLs:
http://www.nsb2014.se/?page_id=1577

Novel DNA barcodes for detection, identification and tracking of stachybotrys and chaetomium species

Detection and identification of indoor fungi in water-damaged buildings is crucial for preventi and control of fungal growth. This study focuses on a molecular method called DNA barcoding. evaluates commonly used sequences in DNA barcoding for fungal species identification Chaetomium and Stachybotrys. The existing DNA barcodes: ITS, SSU, LSU, B-TUB, CMD, RP and TEF-1α do not give satisfying species resolution to be considered as DNA barcodes for the two genera. Therefore, novel barcodes for them are needed. Barcode potentials, such as HOG1 a NAHA, were identified using bioinformatics and are being evaluated in laboratory.

General information
Publication status: Published
Organisations: Department of Biotechnology and Biomedicine, Fungal Degradation, Eukaryotic Molecular Cell Biology, Department of Civil Engineering
Contributors: Lewinska, A. M., Hoof, J. B., Peuhkuri, R. H., Rode, C., Andersen, B.
Number of pages: 8
Pages: 281-288
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Keywords: DNA
Source: FindIt
Source-ID: 2288665240
Research output: Chapter in Book/Report/Conference proceeding Article in proceedings – Annual report year: 2015 Research peer-review
This paper reviews and discusses various sustainable materials utilizing waste products with the focus on their properties having an impact on the indoor environmental conditions and indoor air quality (IAQ). Materials included in the review are selected considering the following aspects: sustainability, cradle to cradle perspective, application, their impact on indoor environment and human well-being. The attempt of the paper is to cover a wide spectrum of information so to provide better understanding of waste utilization in construction industry.

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services
Contributors: Krejcirikova, B., Rode, C., Kolarik, J., Wargocki, P., Peuhkuri, R. H.
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society for Indoor Air Quality and Climate (ISIAQ)
Keywords: Building materials, Waste utilization, Environmental impact, Indoor air quality

Bibliographical note
Topic C5: Environmental impact of buildings
Source: PublicationPreSubmission
Source-ID: 97325061
Research output: Chapter in Book/Report/Conference proceeding - Article in proceedings – Annual report year: 2014
Research: peer-review

ZeroWaste BYG: Hygro-thermal conditions and pollutant emissions from ZeroWaste materials and their effects on humans
General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services
Contributors: Krejcirikova, B., Rode, C., Wargocki, P., Peuhkuri, R. H., Kolarik, J.
Number of pages: 1
Publication date: 2014

Host publication information
Title of host publication: Abstract Book - DTU Sustain Conference 2014
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Research output: Chapter in Book/Report/Conference proceeding - Conference abstract in proceedings – Annual report year: 2014
Research: peer-review

ZeroWaste BYG: Redesigning construction materials towards zero waste society
The ZeroWaste research group (www.zerowaste.byg.dtu.dk) at the Department of Civil Engineering was established in 2012 and covers the broad range of expertise required for turning waste materials into attractive, new materials. Members of the group have developed methods for removal of heavy metals and phosphorous from waste incineration, sewage sludge and other bio ashes [1], providing the basis to make these ash types an attractive, new material for the building sector. The amount of waste increases and it is both difficult and expensive to handle many waste types as e.g. different ashes. At the same time there are fewer natural resources and the general consumption increases. We wish to utilize alternative and new ash types as raw material in concrete, similarly to what was previously seen with fly ash from coal combustion and microsilica, which were both transformed from problematic waste to valuable raw material. The physical-chemical characteristics of fly ash, such as large uniformity coefficient, clay-sized particles and rich in some metal elements and salts, show the possibility of being a raw material also for bricks and lightweight aggregates. In the future we expect increasing political pressure to change the status of different ashes from waste to raw material and that export for disposal will be no longer be allowed. We wish to influence the consequences from this new situation. In principle some of the ashes can be used already, but the huge variation in ash characteristics and lack of knowledge in the construction industry on the qualities some of the ashes can give the concrete and clay materials means that they are not used today.

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Building Design, Section for Structural Engineering, Section for Indoor Environment, Section for Building Physics and Services
Number of pages: 1
Non-isothermal Moisture Transport Through Insulation Materials

An experimental investigation was conducted in order to draw some conclusions on the magnitude of moisture transport due to temperature gradient on a range of porous light-weight building materials. A special constructed non-isothermal set-up allowed the creation of a temperature gradient of 10K and given humidity gradient over the sample. The resulting moisture flux as well as the hygrothermal states around and within the material were monitored. The hypothesis of relative humidity being a driving force for non-isothermal moisture transport already in the hygroscopic range could not be confirmed. On the contrary, indications exist that the temperature gradient itself is driving the moisture from the warm side towards the cold side. An attempt to identify and quantify the single contributions of the different transport forms involved is also presented. The different results gave, however, diverging conclusions and therefore the question about existence of the type of transport forms driven by the non-isothermal effects remains open. Rather surprisingly, all the materials, including the almost non-hygroscopic materials (e.g. rock wool) and very hygroscopic materials (e.g. cellulose insulation) showed the same characteristics.

Investigation of Microclimate by CFD Modeling of Moisture Interactions between Air and Constructions

There is a strong demand for accurate moisture modeling since moisture poses a risk for both the constructions and the indoor climate. This investigation has special focus on moisture modeling. The paper describes a new model based on a CFD tool enhanced to include both detailed modeling of airflows in rooms and heat and moisture transfer in walls by applying them as fluid walls. In a 3D configuration it is investigated what the impacts are of different boundary conditions and how this influences microclimates in rooms. The studied microclimate is a piece of furniture placed near a cold exterior wall.
Effect of airflow velocity on moisture exchange at surfaces of building materials

The moisture transfer between air and construction are affected of the boundary layer conditions close to the surface, which is influenced by the airflow patterns in the room. Therefore an investigation of the relation between the surface resistance and the airflow velocity above a material sample has been performed. The experiments are performed by use of the ordinary cup method for permeability tests. A total of 3 different types of experiments have been performed and for each type different airflow velocities have been tested and compared. As expected the results show that the surface resistances decrease for increasing airflow velocity above the boundary layer of the material surface. The measured resistances are somewhat smaller than the ones estimated by use of the Lewis relation.

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering
Contributors: Mortensen, L. H., Rode, C., Peuhkuri, R. H.
Number of pages: 992
Pages: 187-191
Publication date: 2006

Host publication information
Title of host publication: Research in Building Physics and Building Engineering: 3rd International Conference in Building Physics (Montreal, Canada, 27-31 August 2006)
Publisher: Taylor & Francis
Editors: Fazio, P., Ge, H., Rao, J., Demarais, G.
ISBN (Print): 0-415-41675-2
Source: orbit
Moisture buffer value: A comprehensive analysis of essential parameters

There is an increasing focus on the possibilities of utilizing the absorptive ability of porous materials to create passive control of relative humidity (RH) variations in the indoor air. This has led to the need for determination of a new parameter that can be used for characterization of materials. The dynamic nature of the buffering phenomena makes it difficult to use the standard hygrothermal material properties directly for this purpose. In this paper some experimental results on aerated cellular concrete are used for pointing out the methodological and experimental use of dynamic tests for determination of the moisture buffer value of building materials. Special focus is given to the significance of e.g. the equilibrium state, the step size in the RH and whether one is studying absorption or desorption steps. In addition, the paper summarizes shortly the experience until now of studying the moisture buffer phenomenon. In the experiments the material samples were exposed to a sudden change in the RH of the ambient air which were either consecutive absorption and desorption steps or periodically varying cyclic steps.

Moisture Buffer Value of Building Materials

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Norwegian Building Research Institute, Lund University, VTT - Technical Research Centre of Finland
Contributors: Rode, C., Peuhkuri, R. H., Time, B., Svennberg, K., Ojanen, T.
Publication date: 2006

Publication information
Original language: English

Bibliographical note
Simulation Tests in Whole Building Heat and Moisture Transfer
An important part of the International Energy Agency project, ECBCS, Annex 41 is about modelling the integral heat, air and moisture transfer processes that take place in “whole buildings”. Such modelling deals with all most relevant elements of buildings: The indoor air, the building envelope, the inside constructions, furnishing and systems. These building elements interact with each other and they are influenced by the use of the building, the building services, and the outside climate. IEA Annex 41 aims to reach new modelling possibilities in integral building simulation, and to document these. The paper explains about some new simulation tests used in IEA Annex 41 and elaborates about the challenges brought by these exercises.

The Concept of Moisture Buffer Value of Building Materials and its Application in Building Design

Effect of airflow velocity on moisture exchange at surfaces
Effect of method, step size and drying temperature on sorption isotherms

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Building Materials and Geotechnics
Contributors: Peuhkuri, R. H., Rode, C., Hansen, K. K.
Pages: 31-38
Publication date: 2005

Host publication information
Title of host publication: 7th Nordic Symposium on Building Physics
Place of publication: Reykjavik
Source: orbit
Source-ID: 184612

Full scale tests of moisture buffer capacity of wall materials
Moisture buffer capacity of hygroscopic materials can be used to moderate peaks in the relative humidity (RH) of indoor air as well as moisture content variations in building materials and furnishing. This can help to ensure healthier indoor environments by preventing many processes that are harmful such as growth of house dust mites, surface condensation and mould growth. Therefore a series of experiments has been carried out in a full scale test facility to determine the moisture buffer effect of interior walls of cellular concrete and plaster board constructions. For the cellular concrete, the buffer performance is investigated first for the untreated material, then after adding rendering on the surfaces, and finally with latex paint. Similarly for the walls of plasterboard construction, the buffer effects are investigated first for the insulation (cellulose or mineral wool), then after adding untreated plasterboards as cladding, and finally with additional latex paint. The walls were exposed to cyclic humidity variations like in an inhabited indoor environment, and the response of the indoor humidity was followed over time. The investigations also comprised simultaneous determination of the changes of moisture content in specimens of the wall composites exposed to the same environment. It was found that the finishes had a big impact on the buffer performance of the underlying materials. Even though the untreated cellular concrete had a very high buffer capacity, the effect was strongly reduced even with the supposedly highly vapour permeable rendering finish, not to mention the case when the latex paint was used. In the same way, the experiments for the plaster board construction demonstrated how cellulose insulation, as a very hygroscopic material, is a good buffer compared to the almost non-hygroscopic mineral wool. For example, it was found that if half of the surface area of the walls in a test room consists of cellulose insulation, the variation in RH can be reduced to nearly half of the variation seen for a similar room using non-absorbing materials and the same moisture load. However, subsequent tests demonstrate that for daily humidity variations it is not possible to take advantage of the moisture buffer capacity of the interior layers of a composite wall if the absorbing layers are covered with plasterboard, painted or not.

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering
Contributors: Mortensen, L. H., Rode, C., Peuhkuri, R. H.
Number of pages: 1,214
Pages: 662-669
Publication date: 2005

Host publication information
Title of host publication: Proceedings of the 7th Symposium on Building Physics in the Nordic Countries
Volume: Volume 2
Place of publication: Reykjavik, Iceland
Publisher: The Icelandic Building Research Institute, IBRI
Editor: Johannesson, G.
ISBN (Print): 9979-9174-6-6
Electronic versions:
Paper_NBPS2005_passys_ver.1.1_w_header.pdf
Source: orbit
Source-ID: 181864
Investigation of airflow patterns in microclimates with Particle Image Velocimetry (PIV)

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Stichting Katholieke Universiteit
Contributors: Mortensen, L. H., Mertens, J., Rode, C., Peuhkuri, R. H.
Publication date: 2005

Publication information
Original language: English

Bibliographical note
Source: orbit
Source-ID: 186050
Research output: Book/Report › Report – Annual report year: 2005 › Research

Investigation of microclimate between wall and furniture with CFD
In ordinary building simulation tools for moisture modelling it is common to look very detailed on heat and moisture distributions in constructions while assuming fully mixed conditions in the room air so it is represented by only one node. Opposite, CFD models are used for detailed analysis of airflow patterns in rooms but here the surrounding constructions are described as fixed boundary conditions for the air. In this paper a moisture model for buildings with both airflow velocities and diffusion transport in constructions is presented. The focus of the investigation is on multi-dimensional moisture transfers. Where other models have focused on either the airflows in the room or on the moisture distribution in the constructions this paper will attempt to combine them. The moisture interactions between air and constructions depend strongly upon the airflow conditions close to the surface, which is influenced by the airflow patterns in the room. Thus, it is important to investigate the airflows carefully and to estimate their influence on the moisture transport. Hence, a CFD tool has been used for this investigation. In this paper a moisture model for buildings with both airflow velocities and diffusion transport in constructions is presented. It is a CFD model where the air is modelled as a mixture of dry air and water vapour and walls fluids modelled with ordinary wall characteristics as material properties. This enables easy modelling of moisture transfer within the walls. This investigation has special focus on the coupling of the moisture transfers in the wall and the moisture content of the air. The microclimate in a room is studied for different geometrical configurations, meaning that the moisture and temperature conditions are analysed and discussed using different distances between wall constructions and furnishing.

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Universite Claude Bernard Lyon 1
Contributors: Mortensen, L. H., Woloszyn, M., Rode, C., Peuhkuri, R. H.
Number of pages: 1,214
Pages: 687-694
Publication date: 2005

Host publication information
Title of host publication: Proceedings of the 7th Symposium on Building Physics in the Nordic Countries
Volume: Volume 2
Place of publication: Reykjavik, Iceland
Publisher: The Icelandic Building Research Institute, IBRI
Editor: Johannesson, G.
ISBN (Print): 9979-9174-6-6
Source: orbit
Source-ID: 181863
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2005 › Research › peer-review

Moisture Buffering of Building Materials

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Building Materials and Geotechnics, Norwegian Building Research Institute, Norwegian University of Science and Technology, VTT - Technical Research Centre of Finland, Lund University
NORDTEST Project on Moisture Buffer Value of Materials

Building materials and furnishing used in contact with indoor air have some effect to moderate the variations of indoor humidity in occupied buildings. Very low humidity can be alleviated in winter, as well as can high indoor humidity in summer and during high occupancy loads. Thus, materials can possibly be used as a passive means of establishing indoor climatic conditions, which are comfortable for human occupancy. But so far there has been a lack of a standardized figure to characterize the moisture buffering ability of materials. It has been the objective of a Nordic project, which is currently being completed, to develop a definition, and to declare it in the form of a NORDTEST method. Apart from the definition of the term Moisture Buffer Value, the project also declares a test protocol which expresses how materials should be tested. Finally as a part of the project, some Round Robin Tests have been carried out on various typical building materials. The paper gives an account on the definition of the Moisture Buffer Value, it outlines the content of the test protocol, and it gives some examples of results from the Round Robin Tests.
Response of insulation materials on non-isothermal moisture transport: Final results

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Building Materials and Geotechnics
Contributors: Peuhkuri, R. H., Rode, C., Hansen, K. K.
Pages: 1080-1087
Publication date: 2005

Host publication information
Title of host publication: 7th Nordic Symposium on Building Physics
Place of publication: Reykjavik
Source: orbit
Source-ID: 184613

Subtask 1- Modelling principles and common exercises

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services
Contributors: Woloszyn, M., Peuhkuri, R. H., Mortensen, L. H., Rode, C.
Publication date: 2005

Host publication information
Title of host publication: 26th AIVC International conference
Source: orbit
Source-ID: 184614

Summary Report for Common Exercise 1

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering
Contributors: Rode, C., Peuhkuri, R. H.
Publication date: 2005

Publication information
Original language: English

Bibliographical note
Moisture buffer capacity of different insulation materials

There is an increasing focus on the possibilities of utilizing the absorptive ability of porous materials to create passive control of humidity variations in the indoor air. These variations result in peaks in the indoor air humidity due to moisture production, or in the exterior building envelope due to the diurnal variations of outdoor air temperature and humidity. A passive control of the humidity of the indoor air - particularly together with passive thermal control - may lead to smaller energy use for climatization of buildings. For exterior envelopes, the choice of right materials can lead to more durable constructions. In this paper, a large range of very different thermal insulation materials have been tested in specially constructed laboratory facilities to determine their moisture buffer capacity. Both isothermal and nonisothermal experimental set-ups have been used. In the isothermal tests the material samples were exposed to the same change in the relative humidity of the ambient air on both sides, while the samples were exposed to variations in relative humidity only on the cold side in the non-isothermal tests. The results of these rather different measurement principles are discussed, and different ways are presented how to determine the moisture buffer capacity of the materials using partly standard material parameters and partly parameters determined from the actual measurements. The results so far show that the determination of moisture buffer capacity is very sensitive to the used analysis method and therefore great care has to be taken when comparing results of different experiments. This paper discusses this issue and will come with a recommendation of a simple and consistent way to present the moisture buffer capacity of the materials in contact with the indoor air on the basis of experimental results.

Moisture Dynamics in Building Envelopes

The overall scope of this Thesis "Moisture dynamics in building envelopes" has been to characterise how the various porous insulation materials investigated performed hygrothermally under conditions similar to those in a typical building envelope. As a result of the changing temperature and moisture conditions in the exterior weather and indoor climate the materials dynamically absorb and release moisture. The complexity of the impact of these conditions on the resulting moisture transport and content of the materials has been studied in this Thesis with controlled laboratory tests. The first part of the Thesis consists of a theory and literature review on the moisture storage and transport processes (Chapter 2), on the non-Fickian moisture transport (Chapter 3) and on the methods for determining the moisture properties (Chapter 4). In the second part, the conducted experimental work, results, and analysis are presented (Chapters 5-7). The major findings are discussed (Chapter 8), before the final conclusion (Chapter 9). The Appendices include the material parameters used, some additional results and the description of the simulation models.
Presentation of the International Building Physics Toolbox for Simulink

The international building physics toolbox (IBPT) is a software library specially constructed for HAM system analysis in building physics. The toolbox is constructed as a modular structure of the standard building elements using the graphical programming language Simulink. Two research groups have participated in this project. In order to enable the development of the toolbox, a common modelling platform was defined: a set of unique communication signals, material database and documentation protocol. The IBPT is open source and publicly available on the Internet. Any researcher and student can use, expand, and develop the contents of the toolbox. This paper presents the structure and the backbone of the library. Three examples are given to visualize the possibilities of the toolbox.

Quantifying Time Dependent Moisture Storage and Transport Properties

This paper describes an experimental and numerical approach to quantify the time dependence of sorption mechanisms for some hygroscopic building - mostly insulation - materials. Some investigations of retarded sorption and non-Fickian phenomena, mostly on wood, have given inspiration to the present analysis on these other materials. The true moisture capacity of a material can not be described by the slope of the sorption isotherms alone, when the material is exposed to dynamic changes in the moisture conditions. Still, the assumption of an immediate equilibrium is well accepted in the simulation models. A number of small specimens are exposed to ab- and desorption steps in a controlled relative humidity and temperature. The change in the bulk moisture content is followed continuously as the specimen is directly attached to a balance. The experimental results show retarded sorption. A preliminary approach for determining a sorption coefficient, which can model retarded sorption, is encouraging.
Building Physics Toolbox for Simulink: A (very) brief manual

General information
Publication status: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering
Publication date: 2002

Publication information
Place of publication: Department of Civil Engineering, Technical University of Denmark
Original language: English
Source: orbit
Source-ID: 64279
Research output: Book/Report › Report – Annual report year: 2002 › Research › peer-review

International Building Physics Toolbox: General report

General information
Publication status: Published
Organisations: Department of Civil Engineering, Chalmers University of Technology
Publication date: 2002

Publication information
Place of publication: Gothenburg
Publisher: Chalmers University of Technology, Department of Building Physics
Original language: English
URLs:
http://www.ibpt.org

Bibliographical note
Report R-02:4
Source: orbit
Source-ID: 64302
Research output: Book/Report › Report – Annual report year: 2002 › Research › peer-review

Modeling Building Physics in Simulink

General information
Publication status: Published
Organisations: Department of Civil Engineering
Publication date: 2002

Publication information
Place of publication: Department of Civil Engineering, Technical University of Denmark
Original language: English
Source: orbit
Source-ID: 64282
Research output: Book/Report › Report – Annual report year: 2002 › Research › peer-review

Modelling Building Physics in Simulink: Working draft

General information
Publication status: Published
Organisations: Department of Civil Engineering
Publication date: 2002
Non-isothermal water vapour transmission through porous insulation. Part 2

General information
Publication status: Published
Organisations: Department of Civil Engineering
Contributors: Peuhkuri, R. H.
Publication date: 2002

Event information
Event: 6th Symposium on Building Physics in Nordic Countries
Location: Trondheim, Norway
Source: orbit
Source-ID: 64035
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2002 › Research

SIMULINK model of coupled heat and moisture transport in material layers

General information
Publication status: Published
Organisations: Department of Civil Engineering
Contributors: Peuhkuri, R. H.
Publication date: 2002

Publication information
Publisher: DTU Byg, Danmarks Tekniske Universitet
Original language: English
(Sagsrapport; No. SR-02-02).
Source: orbit
Source-ID: 64029
Research output: Book/Report › Report – Annual report year: 2002 › Research › peer-review

Unfired clay bricks – retention curves and liquid diffusivities
This paper presents retention curves and liquid diffusivities of two different types of unfired clay bricks, both produced in Denmark on commercial basis. The retention curves are determined by use of pressure plate and pressure membrane apparatuses. The liquid diffusivity is calculated on the basis of capillary rise of water measured by use of X-ray equipment. The data from the capillary rise of water is transformed by the Boltzmann transformation.

General information
Publication status: Published
Organisations: Department of Civil Engineering
Contributors: Hansen, K. K., Peuhkuri, R. H., Kristensen, A., Hansen, E. D. P.
Pages: 445-452
Publication date: 2002

Host publication information
Title of host publication: Proceedings of the 6th Symposium on Building Physics in the Nordic Countries
Volume: 1
Place of publication: Trondheim, Norway
Publisher: Skipnes AS
ISBN (Print): 82-91412-02-2
Source: orbit
Source-ID: 64312
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2002 › Research › peer-review

User's guide to the international building physics toolbox: A (very) brief manual

General information
Publication status: Published
Organisations: Department of Civil Engineering, Chalmers University of Technology
Event information
Event: CEN/TC 89 WG 10 "Moisture Calculation"
Location: Chalmers University, Gothenburg, Sweden
Source: orbit
Source-ID: 64039
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2001 › Research

Projects:

Hygrothermal assessment of north facing, cold attic spaces under the eaves with varying structural roof scenarios
Jensen, N. F., Contact Person, Design and Processes, Department of Civil Engineering
Bjarlev, S. P., Project Manager, Design and Processes, Department of Civil Engineering
Johnston, C. J., Collaborative Partner
Pold, C. F. H., Collaborative Partner, Goritas A/S
Hjorslev Hansen, M., Collaborative Partner
Peuhkuri, R. H., Collaborative Partner
01/01/2014 → 01/01/2019
Collaborators: Danish Building Research Institute, Fonden BYG-ERFA
Documents:
Deriving process for Equation 8
Polynomial trendlines and flow relation
Processed data_Phase2
Raw data_Phase1
Raw data_Phase1_Re-arranged
Raw data_Phase2
Raw data_Pressure measurements
Raw data_Tracer gas experiment
Summary of key results
Supplementary graphs for research article
VTT mould model
Project: Research

Symposium om Ventilationsforhold i kolde skunkrum – Etape 2
Symposium 22 februar 2016 på DTU om Ventilationsforhold i kolde skunkrum – Etape 2
Bjarlev, S. P., Project Manager, Design and Processes, Department of Civil Engineering
Johnston, C. J., Project Participant
Peuhkuri, R. H., Project Participant
Hjorslev Hansen, M., Project Participant
Pold, C., PI, Goritas
22/02/2016 → 22/02/2016
Documents:
Skunkrum 2. etape - Nyhedsbrev 1
Invitation og dagsorden til symposium Fugt i kolde tagrum 2016
Skunkrum etape 2 - Symposium introduktion spb
Skunkrum etape 2 - Er det ventilation CJJO
Præsentation af resultater fra kandidatprojekt CP
Skimmel i kolde tagrum RUP
DTU_20160222_Konklusion MHH
Project: Research

Hygrotermisk mikroklima på indvendige overflader af klimakærmen
Mortensen, L. H., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor
Peuhkuri, R. H., Supervisor
Svendsen, S., Examiner
Brohus, H., Examiner
Hagentoft, C. H., Examiner
Forskningsrådssanfinsiering
Hygrothermal performance of internal insulation in historic buildings
Hansen, T. K., PhD Student, Department of Civil Engineering
Bjarlev, S. P., Main Supervisor
Peuhkuri, R. H., Supervisor
Rode, C., Examiner
Blumberga, A., Examiner
Hjorslev Hansen, M., Examiner
Samfinansieret - Andet
01/06/2015 → 14/02/2019
Award relations: Hygrothermal performance of internal insulation in historic buildings
Project: PhD

Eksperimentel og analytisk fugtdynamik i sammensatte bygningskonstruktioner
Peuhkuri, R. H., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor
Hansen, K. K., Supervisor
Holm, A., Examiner
Hjorslev Hansen, M., Examiner
Time, B., Examiner
DTU-lønnet stipendie
01/02/2000 → 17/10/2003
Award relations: Eksperimentel og analytisk fugtdynamik i sammensatte bygningskonstruktioner
Project: PhD

Resistance and susceptibility of the building envelope to fungal growth
Lewinska, A. M., PhD Student, Department of Systems Biology
Andersen, B., Main Supervisor
Hoof, J. B., Supervisor
Peuhkuri, R. H., Supervisor
Rode, C., Supervisor
Frisvad, J. C., Examiner
Adan, O. C. G., Examiner
Jensen, B., Examiner
Eksternt finansieret virksomhed
01/04/2013 → 15/02/2017
Award relations: Resistance and susceptibility of the building envelope to fungal growth
Project: PhD

Hygro-thermal conditions and pollutant emissions from zero waste materials and their effects on humans
Krejcirikova, B., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor
Kolarik, J., Supervisor
Peuhkuri, R. H., Supervisor
Wargocki, P., Supervisor
Qin, M., Examiner
Knudsen, H. N., Examiner
Wadsö, L., Examiner
01/01/2013 → 31/07/2017
Project: PhD

Ventilationsforhold i kolde tagrum som skunkrum og hanebåndslofter i konstruktioner med diffusionsåbne undertage – Etape 2.
Bjarlev, S. P., Project Participant, Department of Civil Engineering, Section for Building Design
Johnston, C. J., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Peuhkuri, R. H., Project Participant, Department of Civil Engineering, Section for Indoor Environment
Hjorslev Hansen, M., Project Participant, Department of Civil Engineering
Project ID: Projekt nr. 26390
01/11/2013 → 31/12/2015
Betingelser for skimmelsvampevækst på byggematerialer
Andersen, B., Project Participant, Department of Systems Biology, Center for Microbial Biotechnology
Møller, E. B., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Rode, C., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Peuhkuri, R. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
04/04/2011 → 31/08/2013
Project: Research

Hygrothermal Performance of Whole Buildings
Rode, C., Project Manager, Department of Civil Engineering, Section for Building Physics and Services
Peuhkuri, R. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Mortensen, L. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Project ID: 25.466
Forskningsrådene - STVF: DKK2,600,000.00
01/05/2003 → 01/05/2006
Award relations: Hygrothermal Performance of Whole Buildings
Project: Research

Whole Building Heat, Air and Moisture Response : IEA ECBCS Annex 41, Subtask 1 leadership
Rode, C., Contact Person, Department of Civil Engineering, Section for Building Physics and Services
Peuhkuri, R. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Mortensen, L. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Project ID: 25617
Forsk. Private danske - Fonde: DKK300,000.00
01/08/2004 → 31/12/2007
Award relations: Whole Building Heat, Air and Moisture Response : IEA ECBCS Annex 41, Subtask 1 leadership
Project: Research

Fugtfordeling i absorberende isoleringsmaterialer : Moisture distribution in absorbent insulation
Rode, C., Project Manager, Department of Civil Engineering, Section for Building Physics and Services
Padfield, T., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Hansen, K. K., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Mortensen, L. H., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Project ID: 25.204
Forskningsprojekter - Mijlø- og Energiministeriet: DKK138,412.00
01/12/2000 → 30/04/2003
Award relations: Fugtfordeling i absorberende isoleringsmaterialer : Moisture distribution in absorbent insulation
Project: Research