

# PROCEEDINGS OF ABSTRACTS



22<sup>nd</sup> - 23<sup>rd</sup> September 2016

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#### **Conference Details**

22 <sup>nd</sup> – 23 <sup>rd</sup> September 2016
Faculty of Civil Engineering, Brno University of Technology
Veveří 331/95, 602 00 Brno
http://envibuild.eu
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#### Determination of Capillary Conductivity Coefficient by Using Electromagnetic Microwave Radiation

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**Keywords:** Capillary Conductivity, Microwave Radiation, Moisture, Inhomogeneous Porous Material.

**Abstract.** Moisture in building structures affects negatively construction material physical properties, particularly thermally insulation properties. The porous structure of most building materials distinguishes by the ability to absorb water in liquid and gaseous state into its internal cavities, to fill the accumulative space of pores, to transport moisture and to re-transmit to the surroundings. The moisture characteristics of building materials are the base for evaluation of building structure thermal insulation properties. The moisture spreading via capillary conduction is the most significant material parameter of a moisture appraisal. However, it is necessary to incorporate also spreading the liquid phase into the moisture appraisal for certain structure material compositions. The article deals with determination of capillary conductivity coefficient by using electromagnetic microwave radiation. The radiation passed through a wet sample is detected and then the value of capillary conductivity coefficient is determined. The coefficient of capillary conductivity is property dependent on several physical parameters, but primarily on the moisture.

#### Effect of Ventilation in Protected Escape Routes upon the Thermal Properties of these Spaces

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**Keywords:** Aeration, protected escape route, positive-pressure ventilation, thermal characteristics.

**Abstract.** Protected escape routes enable the rescuing of persons to the outside of a building on fire. They are characterized, in particular, by strict requirements relating to the aeration of such spaces. However, the fulfilling of these limits may impact the monitored thermal characteristics of the respective internal areas. The outlined dilemma will be illustrated by way of an example of a protected escape route aerated by positive-pressure ventilation.

#### Optimization of Thermal Stability of Atrium based on Computational Modeling

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Keywords: CFD, Atrium, Thermal Comfort, Thermal Loads, Solar Radiation, Air Conditioning, Cooling.

Abstract. The article deals with analysis of the heat balance and temperature microclimate of indoor space of a four-storey building atrium. With regard to the anticipated thermal loads in all functionally connected rooms, investor made a request to verify the thermal stability of the atrium before the implementation stage. Atrium and adjacent rooms are a geometrically complicated inner space which cannot be solved by analytical methods to ensure the required temperature conditions in occupied zone. This led to the creation of a mathematical model of the atrium with the current project solution. The result of the simulation of the existing solutions is that there is not complied desired air temperature in the occupied zone. For this reason, it was developed optimization of existing variant. Optimization was performed in steps as changing temperature of the central air conditioning. The conclusion of this paper is to evaluate the thermal profiles of temperature stratification in the atrium area and request the required cooling performance of the ventilation system. The article attempts to use computer modelling as a tool for the placement and performance design of ventilation equipment.

#### Examination of Mechanical Properties and Temperature Resistance of Epoxy Coatings Filled with Secondary Raw Materials

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**Keywords:** Epoxy Coating, Waste Glass, Tensile Strength, Shore Hardness, Temperature Resistance.

Abstract. Epoxy coatings are used mainly in the construction especially where it is necessary to increase the resistance of concrete floors against mechanical wear, to increase chemical resistance, to prevent dusting and to ensure hygienically clean environment. Epoxy coating is a composite material that consists of epoxy resin cured mainly by polyamine hardener and filler. As a filler is currently used pure silica sand Dorsilit ground to below 0.063 mm and for more demanding applications fine glass flakes with a high proportion of SiO<sub>2</sub>. The aim of this work is to experimentally examine the possibility of using secondary raw materials as fillers into three types of polymer epoxy coatings, where it seems the most appropriate utilization is waste glass with a high content of SiO<sub>2</sub>. Based on the evaluation of the test results of tensile properties, Shore hardness and temperature resistance the possibility of replacing the commonly used filler by finely ground waste glass is assessed.

#### Performance Simulation of External Metal Mesh Screen Devices: A Case Study

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**Keywords:** Solar Shading, Building Performance Simulation, Modeling Approach, Energy Demand, Adaptive Thermal Comfort.

Abstract. Early design decisions with regard to building facade characteristics play a significant role in the resulting building's thermal performance. In this context, external metal mesh screens used as a permanent second facade skin- are a rather new shading alternative, particularly in nonresidential buildings. It has been suggested that such products can filter excessive incident solar radiation while maintaining the facade's transparent quality. Given the multifaceted implications of this shading device for building energy performance, we undertook a detailed simulation-based study to evaluate the impact of metal mesh screens on annual energy demand for heating, cooling and electric lighting in different European climate zones. Possible design variations were considered in terms of mesh screen translucency, window to wall ratio and facade orientation. The feasibility of using such a shading strategy to provide passive cooling during summer was also explored, along with suitable ventilation scenarios. Toward this end, we examined a number of existing approaches to simulate metal mesh screens and identified their capabilities and limitations. A typical office space was tested in three European locations, taking local building construction standards into account. The results of this study can help planners in their choice of the appropriate shading strategy and provide recommendations for the application of metal mesh screens according to the climatic and architectural criteria.

#### Modern Electrical Measurement of Alkali Activated Slag Mortars with Increased Electrical Conductivity

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**Keywords:** Electric Measurement, Alkali-Activated Slag, Building Materials, Carbon Admixtures, Dissipation Factor.

**Abstract.** Slag mortars belong to the new promising alternative construction materials. Conventional cementitious materials are harder to measure by electrical test methods. It is being researched if the dopant atoms in the form of powder improve the mechanical properties. This article describes how the test slag mortars with addition of carbon by electrical impedance spectroscopy measurement methods and their extensions in the form of using ZNC vector analyzer with a coaxial probe from Speag. Impedance spectra of samples were obtained in the 40 Hz to 1 MHz. Declines of impedance by adding more carbon were expected and confirmed. Electrical conductivity and permittivity were measured by vector analyzer for the 100 MHz to 3 GHz. The permittivity was varied from 4 to 20, depending on the addition of carbon, the conductivity of the samples from 1/2600 to  $0.3 \text{ S} \cdot \text{m}^{-1}$ .

#### The Importance of Cooperation between Heating and Ventilation in the Industry Buildings

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Keywords: Ventilation, Air Handling Recovery Unit, Radiant Heating, Industry Large Area Buildings

Abstract. Our national husbandry belongs among economies with the biggest energy consumption per an inhabitant. Slovak Republic consumes for making of product's unit approximately twice more energy than the average in forward European countries. Such a big reserves, that we have to achieve in the area of effective increasing of energy utilization are not possible only by administrative way, but by establishing of new technical solutions into a general practice too. In a part of large-area industry operations, the new technical solution lies in the combination heating system by radiant ceiling panels with ventilation by air handling unit with integrated device for heat recovery, which considerably reduces the operation costs. Paper shows also the basic principles of heat transfer, main construction of the radiant ceiling panel and finally stated objective its advantages and drawbacks.

#### Development and Experimental Verification of Sliding Elements of Transparent Loggia Enclosures in High-rise Building

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**Keywords:** High-Rise Building, Aerodynamic Study, Transparent Loggia Enclosures, Experimental Verification, Pressure Chamber, Acoustic Camera.

**Abstract.** Originally open balconies and loggias of high-rise residential building showed a significant aerodynamic load - discomfort for users. Subject of the contract cooperation with the investor was therefore development, experimental verification and optimization of the strength and functional parameters of sliding elements of transparent loggia enclosures from the effect of the dynamically changing wind pressure (pressure - suction), as well as the elimination of undesirable acoustic expressions. This paper introduces the aerodynamic study of the building with the objective of quantifying the maximum load on sliding elements from the effects of wind as the boundary condition for their dimensioning. It describes the final design of transparent sliding elements and their experimental verification in a large pressure chamber in laboratory. The elimination of undesirable acoustic expressions was successfully implemented through design optimization with use of acoustic camera.

#### **Energy Aspects of Gravitational Ventilation in the Heating Season**

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**Keywords:** Heating, Gravitational Ventilation, Energy Demand, Indoor Air Quality, Thermal Comfort.

Abstract. Natural ventilation is currently widely used in existing buildings in order to assure the fresh air needed by occupants. The low investment and operational costs are the most important advantages of this type of ventilation. However, the dependency on the meteorological parameters has to be considered as disadvantage of the natural ventilation. In case of buoyancy-driven ventilation, the variation of the outdoor temperature results in the variation of the infiltrated air flow, CO<sub>2</sub> concentration in the indoor air and energy demand of the ventilation. The air inlet and outlet orifices have to be properly chosen in order to meet the indoor air quality and energy requirements at the same time. In this paper the  $CO_2$  concentration and energy aspects of gravitational ventilation are discussed in case of a typical block of flats.

#### Experimental Full-Scale Test Cell Optimizing for Research of Novel Concepts towards Climatically Active Solar Façade Design

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Keywords: Test Cell, Full-scale Testing, Dynamic Outdoor Testing, Optimization

**Abstract.** The passive solar test facilities have recently been created in many research centers all over the world to analyse dynamic outdoor phenomena on buildings and their components. The main objective of these research activities is primarily to evolve a methodology, improve test methods, validate numerical models and measure real thermodynamic properties of building components under outdoor climate conditions. An integration of advanced material solutions into buildings need to be investigated within specific conditions related specifically to outdoor test methods. A research project on Contemporary concepts of climatically active solar facades at the Brno University of Technology does have an ambition to create an experimental full-scale test cell for research of thermal aspects in progressive advances of future solar façade concepts exposed to the real climate conditions. This paper describes the design optimization phase preceding the test cell assembly. This phase includes the analysis of energy and thermal properties based on parametric study features. Computer simulations based on finite element and volume methods are involved in the optimization process. The proposed optimized test cell design is confronted with parametrization of typical thermal aspects to present final test cell demonstration.

## **Biomass Use for Low Energy Buildings and Retrofits**

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Keywords: Solid biomass, boiler and system efficiency, primary energy conversion factors.

Abstract. Based on the European EPBD 2010 directive and the mandated method of cost-optimum calculation the forthcoming national regulations require "nearly zero energy buildings" which have high energy performance, significant share of renewables in covering the low energy need and harmonizing the requirement system and the cost-optimum. Known intention of EU Member States as well as some research reports create the impression that predominant use of biomass in the forthcoming years will be the right way to fulfil the above requirements of nearly zero energy buildings. Nevertheless a brief analysis proves that these expectations are exaggerated due to either cost problem or seasonal system efficiency whilst some "secondary" environmental problem must not be forgotten.

## The Risk of Humidity at Greened Façades

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Keywords: Façade Greening, Humidity, Civil Engineering.

**Abstract.** This paper shows the results of a project that investigated the humidity of the air in the ventilation gap of a green façade system. The systems which were investigated are made of aluminium troughs, aluminium modules, or fleece. These systems are mounted on metal rails. The metal rails connect the façade with the plants. This creates a curtain façade that is ventilated by air. The humidity of the air in the gap was investigated, and this paper shows the results of the investigation.

#### An Impact Of Air Permeability On Heat Transfer Through Partitions Insulated With Loose Fiber Materials

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Keywords: Air Permeability, Loose Thermal Insulations, Mineral Wool, Heat Losses, Infiltration.

**Abstract.** The paper presents the problem of windwashing in partitions including air permeable thermal insulations. There are technical solutions, which deliberately accept the filtration of air in the insulating layer, guided by the necessity of possible drying of building materials. Some scientific papers even suggest that the air infiltration decrease the heat losses through ventilation. In result there occur heat losses in building heat balance which are underestimated and therefore difficult to take into account during calculations. Heat changes on the inner surface of the building partition of the wind. However, even the short-term local wind speed loads on thermal insulations result in temperature decreasing and therefore possible condensation on the inner surface of the building partition. The article presents laboratory measurements of air permeability of loose mineral wool and laboratory investigation of the impact of air filtration on heat transfer in lightweight partitions filled with loose thermal insulation.

#### Research on Slaked Lime as Ecological Moisture Retardant on Sheep Wool and Straw

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Keywords: Slaked Lime, Moisture Retardant, Sheep Wool, Straw.

**Abstract:** This paper is about an experiment which should prove that slaked lime is suitable as an ecological moisture retardant. Therefore, the performance of straw, sheep wool, hemp and directed hemp covered with slaked lime was monitored over a long period. The other half of the probes were uncovered to serve as reference data. The main focus of this experiment is to determine the moment when the probes start to mold as extreme humidity in reality only lasts for a short time. During the experiment the used material is continuously exposed to moisture whereas under non-experimental conditions exposure to moisture would last for a much shorter period of time (cooking, cleaning, etc.) This paper only covers the performance of straw and sheep wool covered with lime. Also the spreading of mold will not take place.

## Effect of Glazed Ratio on Indoor Comfort and Energy Need for Heating

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Keywords: Energy Need for Heating, Operative Temperature, Glazed Ratio.

**Abstract.** According to the current national regulations appropriate operative temperature must be provided in premises. Nevertheless simplified calculation methods of heating built-in capacity and energy need for heating are based on indoor air temperature: to have the same output in function of operative temperature requires a series of iteration or dynamic simulation. Experience in existing buildings shows that higher glazed ratio is accompanied by decreasing Mean Radiant Temperature to be counterbalanced with higher indoor air temperature in order to keep the prescribed operative temperature. Nevertheless, in well insulated buildings this effect is weaker. Moreover, it turns into opposite: high Mean Radiant Temperature should be compensated with lower indoor air temperature which considerably decreases the heat loss – especially the ventilation heat loss. Energy need for heating of a sample building is analysed in the function of thermal insulation, glazed ratio and thermal mass.

#### Simulation Study on Thermal Performance of a Ventilated PV Façade Coupled with PCM

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**Keywords:** Building Integrated Photovoltaic/Thermal System, Ventilated Façade, Phase Change Material, PV Temperature.

**Abstract.** This paper presents a dynamic thermal model based on DesignBuilder simulation software platform, for a simple office building model with an integrated ventilated PV façade/solar air collector system in climatic conditions of Bratislava, Slovakia. Thermodynamic simulation has been applied in order to express thermal performance of a ventilated PV façade coupled with phase change material through the whole reference year. Attention is focused on simplified approaches which capture the important elements of the problem. The results of simulation show that natural ventilation of PV façade with added phase change material have ability decrease temperatures of PV panel during extreme days more than 20 °C and shift time of peak temperature even more than 5 hours.

## Impact of External Shading on Light Comort and Energy Efficiency in Apartment Buildings

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**Keywords:** External Shading, Equivalent Shadow Angle, Legislative Limits, Light Comfort, Passive Solar Gain, Energy Efficiency.

**Abstract** The paper introduces an example of a superstructure volume solution designed within legislative limits and its impact on light comfort in shaded flats. It focuses on external shading as a factor affecting hygienic quality, insolation time, and passive solar gain in apartment buildings in Slovak conditions. It pays attention to the assessment of energy efficiency and heat loss during the heating period depending on the amount of external shading, building's orientation and its thermal insulation in all model situations - current, legislatively allowable, and optimized. It also deals with compatibility of optimized shading in terms of hygienic quality and solar gain efficiency to cover heat loss by building envelope in contemporary and prospective low-energy buildings.

#### The Effect of Aggregate Type on the Properties of Lime Mortars

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Keywords: Lime Mortar, Aggregate, Limestone, Quartz, Strength, Porosity, Carbonation.

Abstract. Lime mortars represent an indispensable building materials that have been used for centuries in civil engineering. Considering the necessity of numerous restoration work on historical buildings, a research of the applicability and suitability of various types of plasters for repairing the historical plasters has been developed. This work presents the applicability of limestone aggregate and limestone fines to aerial lime-based mortars. The role of aggregates on the properties of lime mortars is examined in this paper by comparing pure quartz sand and limestone aggregate and its quantity in the mortar. It was found that limestone aggregate produced the comparable or higher mortar strengths than quartz aggregate and slightly increased porosity, water absorptive capacity and carbonation rate of the mortars. Partially replacement of aggregate by limestone fines has caused dramatic growth in strength, especially in mortars with high content of binder. The applied limestone aggregate is convenient to lime-based mortars and the addition of limestone fines to better mechanical properties of lime mortars.

#### **Evaluation of Indoor Climate in Small University Lecture Hall**

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**Keywords:** Parameters of Thermal Comfort, Operation and Design of Small University Lecture Hall.

**Abstract.** This paper is focuses on the evaluation of the indoor climate in the small university lecture hall. Providing the optimal parameters of thermal comfort in the interiors of a university is immensely important for the students of the university. Fulfilling these parameters is inevitable not only for the physiological needs of students but also for the required performance of students. Reconstruction took place in the small university lecture hall. The original windows were exchanged for the modern wood tight windows. Experimental measurements were carried out in the winter season in 2016 in this small university lecture hall in order to evaluate the thermal comfort after the reconstruction. The device Testo 480 was used for the measurements. Obtained values of air temperature, air relative humidity, air velocity, globe temperature and indexes PMV, PPD are presented in the graphs. Heating, operation and architectural design of the small university lecture hall were evaluated on the basis of the parameters of thermal comfort. In the conclusion of this paper, there are principles how to design new small university lecture halls. Furthermore, there are presented recommendations how to operate the existing small university lecture halls.

## Analysis of Thermal Comfort in Flat in New High Residential Building Mária Budiaková<sup>1, a\*</sup>

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Keywords: Thermal Comfort, Heating Design and Architectural Design of Residential Interiors.

**Abstract.** This paper focuses on the analysis of thermal comfort in a flat in the new high residential building. Providing the optimal parameters of thermal comfort in each room of the flat is the basic prerequisite for the satisfaction with housing. Incorrect position and size of heating elements, incorrect positioning of the furniture and incorrect use of residential interiors may significantly disturb the thermal comfort. Residential areas in the new residential buildings are much more intensively used as in the other types of buildings. Surface of new flats is the most optimized. Experimental measurements were carried out in the winter season in 2016 in the residential rooms of the large flat in the new high residential building. Device Testo 480 with temperature and humidity sensor, globe thermometer and turbulence sensor was used for the measurements. Obtained values of air temperature, air relative humidity, air velocity, globe temperature and indexes PMV, PPD are presented in the graphs. Heating system of the flat and the possibility of its regulation, positioning and size of the heating elements in the individual rooms, positioning of the furniture and the utilization of rooms were evaluated on the basis of parameters of thermal comfort. In the conclusion of the paper, there are principles on the architectural design of the residential interiors and their heating in the new residential buildings.

#### Analysis Method for Studying Groundwater under a Church

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Keywords: GPR, Building Materials, Groundwater, Church, Capillarity.

**Abstract.** This paper is focuses on the evaluation of the indoor climate in the small university lecture hall. Providing the optimal parameters of thermal comfort in the interiors of a university is immensely important for the students of the university. Fulfilling these parameters is inevitable not only for the physiological needs of students but also for the required performance of students. Reconstruction took place in the small university lecture hall. The original windows were exchanged for the modern wood tight windows. Experimental measurements were carried out in the winter season in 2016 in this small university lecture hall in order to evaluate the thermal comfort after the reconstruction. The device Testo 480 was used for the measurements. Obtained values of air temperature, air relative humidity, air velocity, globe temperature and indexes PMV, PPD are presented in the graphs. Heating, operation and architectural design of the small university lecture hall were evaluated on the basis of the parameters of thermal comfort. In the conclusion of this paper, there are principles how to design new small university lecture halls. Furthermore, there are presented recommendations how to operate the existing small university lecture halls.

#### **Consideration of Operative Temperature in Design and Operation**

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Keywords: Operative Temperature, Automatic Control, Input Design Data.

**Abstract.** In order to provide appropriate thermal conditions current national regulations prescribe operative temperature as the base of design and operation. In simplified calculation procedure prescribed operative temperature can be provided using a corrected air temperature. Interrelation of operative and indoor air temperature has been investigated in function of overall heat loss coefficient and glazed ratio. Based on regression analysis necessary corrections in function of the above parameters are investigated, the consequences of neglected Mean Radiant Temperature are analysed. Operative temperature represents a control problem, too: disregarding the sensor itself its position in the room, the uneven distribution of radiant field in one room and in the rooms of a flat requires compromises. The possible solutions, their pros and cons are presented.

## A Comparative Assessment of Diffuse Fraction Models

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Keywords: Solar Radiation, Diffuse Fraction Models, Performance Simulation.

Abstract. Many building performance applications (energy use, solar gains, thermal comfort, renewable energy systems, daylight, etc.) require information about both direct and diffuse components of the incident solar radiation. However, most meteorological stations only monitor global horizontal irradiance. Consequently, multiple methods have been proposed in the past to derive from measured global horizontal irradiance data the diffuse fraction. Thereby, additional data regarding other parameters such as clearness index, solar altitude, air mass, and turbidity are used. Given the importance of this procedure for the down the line tools, its reliability represents a critical issue. To address this point, we pursued an empirical approach. A number of existing methods for the computation of the diffuse fraction were selected. Actual measurements of global and diffuse irradiance were obtained for seven locations in USA and one location in Austria. The measured global irradiance data for these locations were fed to the aforementioned diffuse fraction models. The calculation results were then compared with the corresponding empirical data. The comparative assessment yielded a number of findings. The relative performance ("ranking") of the models was found to be more or less consistent across the different locations. However, none of the models can be said to be performing wholly satisfactory. For instance, the best performing model displayed only in 45 to 65 percentage of the cases relative errors less than 20%. In case of the worst performing model, the percentage of the cases for which relative errors were less than 20% was even smaller, namely 30% to 60%.

## The Implications of Assumed Boundary Conditions for The Reliability of Indoor Illuminance Predictions: A Case Study

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Keywords: Sky Luminance Distribution Models, Indoor Illuminance.

Abstract. In order to model daylight availability and distribution in architectural spaces, simulation tools require reliable representations of boundary conditions – typically in terms of sky luminance distribution models. However, the impact of sky model errors on simulation-based indoor illuminance predictions is not well documented. There are different tools and methods to simulate indoor illuminance conditions and related daylight indicators. In the present study, we selected Radiance lighting simulation program. In order to generate sky scene description, Radiance contains two routines, namely, Gendaylit and Gensky. These routines require, as input, information on both direct and diffuse components of solar radiation. To explore the implications of the sky model selection on the fidelity of simulation results, we used Radiance to compute the indoor illuminance in an existing test space on the rooftop of a university building. Thereby, the aforementioned two sky models were considered. A third option (SC) was a sky model generated based on measured values obtained from a sky scanner. Simultaneously, the actual illuminance levels in this room were monitored under different outdoor conditions (clear, intermediate, overcast). The comparison of the measurement results with multiple model prediction results facilitates an empirically based evaluation of the reliability of indoor illuminance predictions in the face of different assumptions pertaining to the prevailing boundary conditions.

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**Keywords:** Building Product Data, Stakeholders, Questionnaire, Building Product Representation, Repositories

**Abstract.** The timely availability and quality of building product information is critical prerequisite for a successful building delivery process. However, little is known about the processes by which stakeholders acquire and use such data. This contribution documents the results of recent relevant surveys, addressing the building product data processing by planers, clients, and the industry. Web questionnaires and interviews with opinion leaders were conducted. Altogether, over 100 participants provided pertinent insights regarding strengths and weaknesses of the current data representation practices. A comparison of the obtained data with that of an earlier study allows for the documentation of the evolutionary trends in web-based data provision. Most importantly, the results facilitate the formulation of strategies for a more effective presentation and distribution of building product data.

#### Characterization of Lightweight Concrete Produced from Plastics Waste – Polystyrene and EVA

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Keywords: lightweight concrete, waste, plastic, polystyrene, ethylene vinyl acetate (EVA).

Abstract. In this paper, the lightweight concrete made from polystyrene and ethylene vinyl acetate (EVA) waste was studied. EVA waste from footwear industry and waste polystyrene were used as an aggregate in the lightweight concrete. The plastic waste was used as the only aggregate or as a combination of both materials in a ratio of 1:3, 1:1 and 3:1. The water-cement ratio of 0.50 and the dose of cement – 175 kg·m-3 were used for all mixtures. Test results showed that the bulk density and the thermal conductivity of lightweight concrete tended to increase with increasing EVA waste content. The maximum compressive strength of lightweight concrete was reached with the waste material in a ratio of 1:1. Based on the results, the application of EVA waste as lightweight filler showed a good possibility for use in the lightweight concrete.

#### Criteria and Indicators for Assessment of NZEB in Slovakia

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Keywords: Indicators, energy need, energy use, primary energy

**Abstract.** Building energy design is currently going through a period of major changes. One key factor of this is the adoption of nearly zero energy buildings as a long term goal for new buildings in most developed countries. To achieve this goal a lot of research is needed to accumulate knowledge and to utilize it in practical applications. Paper summarizes criteria and indicators prepared in law and technical documents in Slovakia.

#### Recommendations for Automatic Opening Vents (AOV) in an Office Building in Terms of Thermal Instability in Relation to Natural Ventilation and Cooling

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**Keywords:** Automatic Opening Vents, Natural Ventilation, Building Simulation, Simulation Instability.

Abstract. One of the optimal and most economic ways of completing a thermal assessment of a building is with a precise dynamic thermal simulation, where a building envelope and its systems are simulated and evaluated in a virtual climate using real meteorological data. The simulation parameters can be exported to a Building Management System for a particular building, as simulation problems of natural ventilation reflects the real behaviour of a building. Instability of dynamic thermal simulation is a typical issue for certain conditions, as window operations can cause excessive interior temperature fluctuations and even trigger the heating system if the common ON/OFF or simple linear operation function is used. To solve the problem, reduction of the simulation time-step is usually used, though the principle of the air flow is not handled. Additionally this solution multiplies the simulation complexity, though the instability of the model is significantly reduced. The case model clearly showed a negative contribution of AOVs operated by linear function related to temperature or  $CO_2$  at initial simulations, by increasing the energy consumption of the building.
# Rule Based Building Construction Generation: An Approach Based on Formal Language Methods

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**Keywords:** Formal Modelling Approaches, Building Constructions, Layered Compositions, Thermal Building Performance, Automation in Construction.

Abstract. The composition of efficient and appropriate building constructions is a key agenda in the building delivery process. While this process is regularly considered to be of highest importance for the final quality of a building, many involved stakeholders regard it as a cumbersome and repetitive routine. Therefore, approaches to facilitate this process should be investigated. Toward this end, we address the layer-wise building component composition via formal language methods. These are regularly used in computer science to formalize real-world processes into a language that can be processed by a computer. Regarding building component generation, relationships and interdependencies between different layers need to be considered. While these are easy to understand for a skilled human planner with pertinent domain knowledge, the exact formulation of building composition rules is far from trivial. Thus, automated building part generation requires collection and formalization of the required knowledge regarding building component composition, so that it can be readily transformed into a processual form. After collection, definition and structuring of such rules, the overall process of component generation can be expressed in Pseudo-Code. This offers three major advantages: i. Pseudo-code is vendor and platform neutral and is a widely used concept in computer science; ii. Potential mistakes and issues can be easily identified, iii. Flexibility, extensibility and editing ease is ensured. In this contribution we illustrate a general approach, define certain rules and thresholds, and introduce a formalized method for building part generation. Furthermore, we demonstrate the concept via a limited number of constructions and discuss potential application scenarios.

# Comparison of Driving Rain Index Calculated According to EN 15927-3 to the CFD Simulation and Experimental Measurement

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**Keywords:** Measurement, TRY, Heat-Air Moisture Simulation, HAM, Wind-Driven Rain, Airfield Hourly Index, CFD, Slovakia, Bratislava.

**Abstract.** Wind-driven rain or driving rain is a rain which has given a horizontal velocity component by the wind. It can be the important moisture source for building façades and has been of the great concern in building science. In this article, the normative method described in STN EN ISO 15927-3:2009, was used for calculation of driving rain impact on vertical surfaces. This amount of rain was compared to the CFD simulation for selected location and to the experimental measurement carried out by wind-driven rain gauge.

# Comparison Of Meteorological Climate Data Sets From Greater Žilina And Their Influence On Temperatures Within The Experimental Wall

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**Keywords:** Exterior Temperatures, Weather Stations, Comparison of Data Sets, Real Boundary Conditions.

**Abstract.** The experimental wall fragment (consisting of five different sections) was completed in 2010. Temperatures inside the sections had been recorded since. The laboratory centre of our department is also equipped with the own detached experimental weather station. In this paper, the outdoor boundary conditions obtained from the experimental weather station are compared to the automated weather station Dolny Hricov and to the phenological weather station in Zilina (with registering period of three times a day), both maintained by Slovak Hydrometeorological Institute (SHMU). For the comparison, there were selected 14 days from the years 2014-2016, to find some extremes. Differences between the data sets obtained from the stations were computed to each other and analysed in terms of boundary conditions for the HAM computer simulations. Differences between the temperatures under finish of the experimental wall fragment were found out by use of ESP-r software.

#### Constitutive Laws Assessment for Unconfined Concrete under Compression

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Keywords: Constitutive Laws, Concrete, Structures, Microplane, Continuum Damage

Abstract. Nowadays, the rehabilitation of buildings takes more importance due to sustainability reasons. This involves working with existing building structures and the precise calculus of the building to guarantee the adequate strength and safety, from structures with change of use to deteriorated or damaged structures. Concrete is the most common material in building structures, but it is a heterogeneous and non-linear material. The concrete constitutive law, relation between strains and stresses in different directions, is very complex, and different in tension and compression. In the case of new construction project, the linear relationship between stress and strain has been proved safe enough, but it is unable to simulate the behaviour of used and damaged structures, where it is necessary to study the entire load range. In this work, the most widely used constitutive laws of concrete are compared, parameterizing the necessary constants for their professional application in advanced simulation structures software. Some of the evaluated constants are the Young's modulus, Poisson's ratio, stress cracking and crushing, failure energy or the law of damage evolution. Linear-multilinear behaviour, Willam-Warnke crushing and cracking criteria, continuum damage and microplane options are the assessed constitutive laws, showing the differences between the behaviour models and the tightest values of these material constants along the entire load range.

# Parametric Analysis of Floor Cooling

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Keywords: Floor Cooling, Parametrical Analysis, Nomogram, Numerical Simulation, Software CalA.

**Abstract.** This study is aimed at parametric analysis of floor cooling. Impact of several design parameters such as air temperature, temperature of cooling water, distance of cooling pipes, thickness and thermal conductivity of top layer on total heat transfer of cooling floor is studied. The issue is solved by steady-state 2D numerical simulation of heat transfer to the floor construction. These parametric simulations are performed in software CalA. Impact of variable input parameters on total heat transfer is observed. Results of parametric analysis are displayed in a nomogram. This nomogram is useful for faster designing of floor cooling.

## Reinforcement-Dependent Thermal Properties of Reinforced Concrete Columns and Slabs

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Keywords: Building Physics, Thermal Conductivity, Reinforced Concrete, Finite Element Analysis.

**Abstract.** Energy efficiency aspects are rarely considered during practical structural design. In building energetic calculations, thermal conductivity values from EN ISO 10456:2008 [1] are mainly used, although the standard define concrete's values only by taking into account the density and the approximate percentage of reinforcement. Details of the structure type (column or slab), reinforcement (e.g. direction, diameter, amount of rebar spacers) and other properties (e.g. concrete composition) are not mentioned. In this research, we uncover the possible relations between the steel content parameters and thermal properties by laboratory measurements of 1:2 scaled reinforced concrete specimens and validated finite element models of columns and slabs with different designed reinforcements. Results shows, that depending on the structure type, design and steel content, there is a difference in the structure's equivalent thermal conductivity. Our results and experiences of this research possibly can be used in energy conscious structural design practice.

# The Impact of Decisions Made in Various Architectural Design Stages on Life Cycle Assessment Results

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Keywords: LCA; building life cycle assessment; early design phase; parameter analysis.

**Abstract.** Life Cycle Assessment (LCA) is an advantageous tool for the analysis of the overall environmental effects of a building. Most of the decisions that influence the final result of an LCA are made during the design process of the building. Therefore, LCA in early design stages is crucial, because the changes in this period of design are cheaper and more effective. However, there are many other aspects that influence the design of a building. During the design process a high number of variables have to be defined, and in each design stage a specific number of variables have to be fixed depending on various engineering considerations. In this paper we investigate the effect of decisions made in each design stage on LCA results. Within this paper the available possibilities are compared with the variant that was actually selected in each stage, and it is evaluated how environmental indicators evolve during the whole design process. The approach is demonstrated on a case study of a realized single family house.

# The Effect of Boundary Conditions to Specify the Energy Performance of Buildings

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Keywords: energy performance of buildings, boundary conditions, impact of energy specialists

**Abstract.** The overall energy performance of buildings is determined not only based on structural and material solutions of the building. An important factor have boundary conditions for task of building. The task of boundary conditions to affect the result of evaluating the energy performance of building. The article is devoted to the evaluation and selection of energy performance of buildings in case of changing boundary conditions and their evaluation. The contribution is describes of change in the intensity of ventilation the building, change of assignment accumulation structures and change the assignment influence of thermal binding.

### **Double Windows in Heritage Listed Buildings**

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**Keywords:** Double windows, Heritage Listed Buildings, Surface Temperatures, Relative Air Humidity.

**Abstract.** Heritage listed buildings, or their parts, are subject to the decisions of state authorities in the field of heritage preservation. When windows are reconstructed, the requirements concerning the new design are most often based on the original appearance of the windows. In the case of double windows - the traditional style with space and reveal in between - the outer window is installed with insulated glazing while the inner window has a simple glazing, in order to meet the conditions of thermal related technical standards. For this reason, the contact between the window frame and the reveal must be tight with very low air permeability. The article presents the measurements of surface temperatures of both of the window parts and explores the issue of thermal humidity condition in the area between the windows.

### Dynamic Heat and Moisture Transport Modeling of Industrial Floors on Different Climates

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Keywords: Dynamic Simulation, Heat and Moisture Transfer, Industrial Floor, Building Physics

**Abstract.** In this paper a conjugated heat and moisture transport investigation of industrial floors is presented. We have analyzed 2D general segments of wall and foundation connections in three different climatic conditions: Budapest (Hungary), Lisbon (Portugal) and Espoo (Finland). We also modeled the component with horizontal or vertical edge insulations with various thicknesses and lengths, and two different soil compositions under the floors. The design of the floor and wall components was performed according to the current standards. We examined 126 combination of the segment and the results shows difference both in relative humidity across the components and heat losses through the internal faces. In conclusion, the simulations and results can improve the energy efficient design of industrial buildings across Europe.

## Environmental Assessment of Buildings Constructed by Modern Methods of Construction

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**Keywords:** Environmental Assessment, Modern Methods of Construction, Life Cycle Assessment, Construction, Case Study.

**Abstract.** Currently, we are witnessing the significant impact of industrial activity on the environment. A recent study shows that construction is the third largest industry sector in terms of environmental pollution. One option to reduce these negative effects is environmental assessment of buildings, as well as the used building materials. One of the most comprehensive environmental assessment methods is LCA (Life Cycle Assessment), which includes the assessment of impacts within mode "Cradle-to-gate" which is focused on assessment of a partial product life cycle from resource extraction (cradle) to the factory gate (i.e., before it is transported to the consumer). The aim of this paper is a comparison of the environmental impact of selected material variants applied within modern methods of construction. The comparison will be processed through the results of the case study containing three material variants of family houses construction in term of three selected parameters - embodied energy, global warming potential and acidification potential..

# Occurrence of Microorganisms on Insulated Facades in the Selected Locality (Ostrava – Poruba)

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Keywords: Microbiotic attack, ETICS, Poruba locality, Ostrava.

**Abstract.** Occurrence of microorganisms on insulated facades in the selected location (Ostrava-Poruba). Occurrence of microorganisms on facades is more and more common. It benefits mostly from facade insulation. This problem is not only esthetical. Incidence of microscopic fungi increased thanks to environmental changes. Every person is breathing spores (reproductive particles of mould) unknowingly. There is evidence that spores are closely related to respiratory illnesses. Objects that are vulnerable to microorganisms should be managed in a way, where there is no risk of harm to us or people around us.

#### **Experimental Preparation of Magnesium Oxide Board**

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**Keywords:** Magnesium Oxide Board, Experimental Preparation, Composition of MgO Board, Tensile Strength in Bending

**Abstract.** In the present, global production of magnesium oxide (MgO) boards comes exclusively from China. However, Slovakia is one of the leading countries in the mining of magnesite. Therefore, an experiment of MgO board preparation from local resources was realized. The experimental board was made from the calcined magnesite mined out in Hačava in Eastern Slovakia. The paper describes the production process of the MgO board in laboratory conditions. In order to compare the experimental MgO board with a MgO board from China, the tensile strength in bending was examined. The experiment demonstrates that the tensile strength of the experimental MgO board in bending in one direction is higher than the declared strength of the commercial board, but in the second direction it is nearly a half of the MgO board production from local resources.

#### Analysis of Unreinforced Ceramic Wall Panels in the Mounting State

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**Keywords:** Prefabricated Ceramic Panel, Mounting State, Shapes of Panels, Bending in its own Plane, Static Issues.

**Abstract.** Properties of building materials used for the construction of surrounding structures significantly contribute to creating a healthy and comfortable microclimate inside the rooms. Ceramics belong among materials which exhibit very suitable properties for the formation of the healthy environment. It is also one of the reasons that the fired clay structures remain popular among builders and that recovery of ceramic prefabrication can be seen in the Czech Republic. The important step towards rediscovering the benefits of the prefabricated ceramic elements is forthcoming production of unreinforced ceramic wall panels made of fired clay masonry units with tongue and groove, connected in the bed joints by two-component adhesives. Conventional analytical model for vertical loads is used in the operating state. However, in the transport and mounting state it is a structure stressed by bending in its own plane. This paper is focused on the issue of load-bearing capacity of structures with masonry units cross-sections that are not filled in head joints and therefore are unable to transfer either tensile or compressive stresses. On the segment of the wall panel is performed numerical model analysis using the finite element method in the computing program ANSYS and comparison of this analysis results with the results of the experimental tests.

## The Development of Lightweight Thermal Insulation Plasters and Experimental Analysis of Their Moisture Behavior

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**Keywords:** Thermal Insulation Plasters, Moisture Transport, Lightweight Aggregate, Hydrophobic Agent, Porosity, Thermal Conductivity.

**Abstract.** The development of lightweight thermal insulation plasters containing alternative binders as a partial cement substitute opens the possibilities of using new, eco-friendly materials in civil engineering. The substitution of cement significantly reduces the energy consumption these materials' manufacturing. In addition, they contribute to the overall energy performance of buildings, which represents another environmental benefit. Concerning the negative effect moisture has on the thermal insulation properties of plasters, the investigation focused on the influence of various hydrophobic agents on the hygrothermal behaviour of the newly developed porous materials. The goal of the research was to develop eco-friendly thermal insulation and rehabilitation silicate materials and to analyse their moisture transport

## Impact of Inlet Boundary Conditions on the Fluid Distribution of Supply Duct

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Keywords: Ventilation, CFD, Flow Distribution, Inlet Conditions, Air Conditioning.

Abstract. Ventilation is important to maintain the indoor air quality and other comfort parameters in the occupied zone. The design of ventilation systems is based on one dimensional approach. When the air distribution is modelled in the ventilated space usually CFD simulation is performed and simplified boundary conditions are defined at the locations where the supply air enters the room. However, in some cases it is difficult to predict the duct flow by 1D methods. The flow in the duct system determines the outflow at the air terminal devices. The interaction between the multiple system elements is important, since many different combinations are possible, for instance multiple bends can create a special flow field which also influences the distribution performance of the duct. It is very important to determine this impact, because the room airflow depends on it. In this study the impact of the inlet boundary conditions on the fluid distribution performance of a special supply duct – which is designed to provide uniform distribution – is investigated with CFD. Three different inlet boundary conditions are defined: constant inlet velocity and turbulence parameters estimated from intensity and hydraulic diameter, diffuser after fully developed turbulent pipe flow, diffuser with one bend and a Venturi-tube upstream. In each case, the simulations are performed with the realizable k-epsilon model. The reliability of the results is estimated with the grid convergence index.

# Long-time Measurement of Experimental Walls Suitable for Low Energy Buildings Exposed to the Outdoor Climate - Hygrothermal Durability and Thermal Performance.

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**Keywords:** Lightweight Wall, Wooden Frame, Zero Energy Building, Experiment, Simulation, HAM, Heat-Air-Moisture, Long-Term, Thermal Conductivity.

**Abstract.** Five lightweight timber-frame wall sections with various thermal insulations, vapour barriers and outdoor coating colours were exposed to the real outdoor climate since 2011. The indoor boundary conditions were maintained by the air conditioning unit. After five years of exposure, the experimental wall was dismantled. The samples from thermal insulations were collected and the mass moisture content and thermal conductivity were found out. This article compares designed and measured values of thermal conductivity and the temperature inside five sections to simulation in WUFI Pro. The wall sections differ from each other with thermal insulation: mineral wool, glass wool and hemp and by the colour of the outer surface: white, grey and yellow. Considering the vapour transport in composition, there are three variants: without the vapour barrier, with the classic vapour barrier and with the vapour barrier with changeable diffusional resistance. There are thermal sensors located in each section. Samples of the thermal insulation were taken from the sections and the water content was measured by the gravimetric method twice – before and after the winter period.

# Monitoring of a Prototypical Free-Running Building: A Case Study in a Hot-and-Humid Climate

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**Keywords:** Thermal Comfort, Hot-and-Humid Climate, Long-Term Monitoring, Indoor Climatic Assessment, Sustainable Building.

Abstract. The provision of comfortable indoor conditions is widely considered as one of the key tasks of architecture. Hereby, different climatic regions require different concepts for the operation of buildings. Achieving thermal comfort in buildings in hot and humid regions without Air-Conditioning can be considered as a challenging task. In this context we present a monitoring study of the indoor conditions in a new prototype building, called the Zero Carbon Resort Demonstration Cottage. This building was designed according to passive cooling principles with the intent to reach a high degree of sustainability and to have little environmental impact. To explore the viability of this concept, we deployed a comprehensive monitoring of the outdoor conditions via a weather station and of the indoor conditions via air temperature and relative humidity sensors. Moreover, short-term monitoring of thermal comfort was conducted. In a first analysis step we compared the results of the indoor monitoring with the corresponding outdoor measurements. In a second step we conducted a standardized thermal comfort study. Thereby we considered the special circumstances of the thermal comfort in naturally ventilated buildings. Results suggest that acceptable indoor conditions can be maintained, if passive cooling methods are applied properly.

### Finite Element Analysis of Composite Ceramic-Concrete Slab Constructions Exposed to Fire

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**Keywords:** Finite Element Analysis, Thermal Simulation, Computational Fluid Dynamics, Elevated Temperature, Fire Safety, Hollow Ceramic Slabs.

**Abstract.** In this research, conjugated thermal and fluid dynamics simulations are presented on a modern hollow clay slab blocks filled pre-stressed reinforced concrete beam slab construction. The simulation parameters were set from Eurocode standards and calibrated using data from standardized fire tests of the same slab construction. We evaluated the temperature distributions of the slabs under transient conditions against standard fire load. Knowing the temperature distribution against time at certain points of the structure, the loss of load bearing capacity of the structure is definable at elevated temperatures. The results demonstrated that we could pre-establish the thermal behavior of complex composite structures exposed to fire using thermal and CFD simulation tools. Our results and method of fire resistance tests can contribute to fire safety planning of buildings.

# Study on Surface Treatments of Modified Wood Plastic Composite (WPC) to Improve Adhesion

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**Keywords:** Adhesion, Cohesion, Surface Modification, Sandpaper, Diffuse Coplanar Surface Barrier Discharge, Low-Cost Plasma, Wood Plastic Composite.

**Abstract.** The presented case study is focused on the complications that affect the adhesion properties of wood plastic composites. In an effort to improve the physical properties of the WPC and the adhesive bonding between the selected material and adhesive systems intended for façade bonding, several surface pretreatments were performed. The surface modification consisted of mechanical roughening or physical treatment with diffuse coplanar surface barrier discharge. The shear strength of the adhesive bond was tested following ČSN EN 1465 and the maximum shear stress was calculated for each treatment method. Although, the increase in bond strength due to these treatments was measured only for one tested adhesive system where the strength was increased by 100% with respect to the control, the diffuse plasma treatment improved the adhesive bondability and a change in failure mode was observed in all tested cases.

## Moisture Monitoring of Built-in Wooden Elements

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Keywords: Build-in Wooden Elements, Wood Moisture Measurement, Resistance Method.

**Abstract.** This paper describes moisture monitoring of wooden elements, which are built-in to structures of building envelopes. This monitoring is helpful in proving long-term functionality of designed details or, conversely, in pointing out of an emerging problem, thus avoiding infestation of these elements by wood decaying fungi or insects, which is usually connected with excessive wood moisture. This can occur in these elements especially when they go through the building envelope from interior to exterior. The described long-term measurement is based on a resistance method and the text explains its principle, mentions factors influencing the accuracy of measurement and shows installation and development of probes, which were designed by author for this kind of measurements.

# Current Importance of Glasses and Influence of the Weakening of Glass Surfaces on Glass Strength

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Keywords: Glass, strength, tears, linear elastic fracture mechanics, weakening of surface.

**Abstract.** Purpose of this work is of current importance and failure due to surface cracks in glass. This significance has risen compared to past. The nowadays tendencies are stated and the glass functions, which infiltrated to the top in terms of technology and architecture, are summarized. At its peak the glass also applies to a significant failure rate due to its extreme sensitivity to breaching of the surface quality. In connection, the comparison of strength of an undistorted almost perfect element and element surface subjected to external influences, in which can be seen more slight weakening in its surface, is presented. The processes under stress which could, in the extreme, lead to the weakening of the surface to total fracture are reported. Knowing the processes and locating the first crack we can see significant minimization of the total capacity. Summarizing of allegations stated in the text shows that its sensitivity causes a sudden fracture resulting in weakening of the glass surface. Weakening of surface due to normal wear cannot be eliminated. Cited theory of the process of stress and fracture of the glass highlights the significant influence of surface quality even at an affordable and technically sophisticated system that might even with the slightest cracks suddenly fail.

# Experiment Based Analysis of Complex Posterior Waterproofing Systems

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Keywords: posterior waterproofing, chemical injection, rising damp, hygrothermal analysis

Abstract. In connection with the problems of aging European building stock, the opportunity of posterior waterproofing methods emerges as a relevant solution. There are different technologies which are suitable against rising damp in walls, but the chemical injection system through injection boreholes is the most commonly used method due to its extensive usability and fast implementation. The aim of the experimental research was to measure the efficiency of the chemical injection method by the penetration of the injection agents. There were built several specimens of small size solid bricks and some further ones of coarse limestones. The 3 months long research allowed to determine the moisture content of the specimens before and after the injection process. The received results were mass-based and moisture content data was measured by Protimeter. Surface coating and renovation plaster give additional moisture protection and along with the chemical injection provide a complete posterior waterproofing system. The elements of posterior waterproofing cause changes in the vapour diffusion of renovated structures. However, diffusion-open orders of layers can solve the problem of evaporation, as environmental friendly reconstruction solutions. Based on the measured results of rising damp and known characteristics of cement-based waterproofing and renovation plasters, thermal simulations and hygrothermal analysis and thus building physical conclusions have been performed.

# Energy Saving Potential of Personalized Ventilation Applied in an Open Space Office under Winter Conditions

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**Keywords:** Computer Simulation, Ventilation, Office Building, Indoor Environment, Control Strategy.

Abstract. Mixing and displacement air distribution are the main ventilation principles applied in both residential and non-residential buildings. Recently, personalized ventilation when the fresh air is delivered directly to the occupants at a high ventilation effectiveness has become an alternative. Despite of this fact, little research has been carried out to quantify the energy saving potential of personalized ventilation. This study aimed to quantify the effect of ventilation effectiveness and control strategy on the energy performance and thermal comfort for an open plan office equipped by different types of ventilation systems, including mixing ventilation with constant air volume, demand control ventilation and personalized ventilation. A model was created in a program for dynamic energy simulations TRNSYS, representing one floor of a typical office building divided into four zones with different orientations and a core. Space heating and cooling were provided by ceiling fancoil units recirculating the room air, thus the tasks of ventilation and air conditioning were provided by two separate systems. The potential of personalized ventilation to save energy for fans and for the heating coil of the ventilation system presented about 70% compared to constant air volume mixing ventilation, however, the overall saving was only 20% when also the energy demand for space heating was considered. The energy benefit of demand control ventilation and personalized ventilation depends on the energy need for space heating and cooling, system configuration and operation, and occupancy.

#### Material of Thermal Insulation affects Heat Gains in the Summer Period

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Keywords: Pitched Roof, Attic Room, Thermal Inertia, Heat Transfer.

**Abstract.** Buildings with light-weight roof structures tend to suffer from overheating of attic spaces during the summer period. One of the methods for improving the indoor thermal comfort with no energy consumption is reducing the heat flux passing through the building envelope. In particular, this can be achieved by increasing the thermal inertia of the roof, specifically, by choosing materials with relatively high density and high specific heat capacity. This article focuses on evaluating of the roof assembly of an inclined insulated non-ventilated roof which meets the requirements for the passive house standard. A dynamic Comsol simulation with harmonic fluctuation of the exterior temperature was used to express the impact of the structure on the temperature damping and the time lag. The period of 7 days was screened. As a result temperature profiles of several material variants are compared.

# The Testing of Fire Retardants

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Keywords: Fire retardants, testing, wood modifications, fire protection.

Abstract. The collective of authors deals with the importance and significance of fire retardants for the purpose of fire protection in practice. The main aim of this article is to inform the general public about the possibilities of modifications of wood by fire retardants. Authors made the experiment present the testing of test specimens of wood by means of experimental scientific method of test for limited flame spread in the test bench under laboratory conditions. The results of the experiment represent fire-technical characteristics that describe the behavior of wood during the process of combustion. Based on the measured data are exactly evaluated different types of fire retardants by selected evaluation criteria, specifically the weight loss of test specimens. The conclusion is the effectiveness of fire retardants modifications and to perform the necessary adjustments and proceedings.

#### Energy balance concepts of apartments dwelling houses renovation

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Keywords: Renovation, Apartment dwelling houses, Energy, Building, CO2

Abstract. In members states of the European Union (EU), portion of buildings in the total consumption of energy represents 40%, and their share in  $CO_2$  emissions represents 35%. Taking into account dependence of the EU on import of energy, this represents a large quantity of energy and  $CO_2$  in spite of the fact that effective solutions for the reduction of energy demand of buildings exist. The EU adopted three main commitments for fulfilment of criteria by year 2020 in the 20-20-20 Directive. On the basis of the aforementioned directive, the Slovak Republic (SR) declares support for the renovation of apartment dwelling houses (ADH). Taking into account the fact that the state support can be obtained only once, and energy requirements of the EU are increasingly stricter, it is inevitable to approach to the renovation of buildings comprehensively. At the same time, it is inevitable to propose the renovation of buildings taking into account requirements for buildings until 2020. The paper divides ADH in the SR into three categories according to the existing renovation state. There are ADH without any renovation, after partial renovation and after comprehensive renovation. Within the case study, energy balances and CO<sub>2</sub> emissions were compared for all categories. Based on results it is obvious that energy saving up to 50% is achieved after the partial renovation in comparison with the solution without any renovation. In the case of comprehensive renovation, energy savings exceed 80% in comparison with ADH without renovation.

# Evaluation the Contribution of Plate Enthalpy Exchanger in Air-Conditioning

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**Keywords:** Enthalpy Exchanger, Heat and Mass transfer, Ventilation, Air-condition, Humidity, Indoor Climate,

**Abstract.** This paper is focused on theoretic application of plate enthalpy exchanger in real environment. This paper is focused on advantages / disadvantages of these exchangers compared to heat exchangers used today. Plate enthalpy exchanger is able to realize heat transfer and mass transfer thanks to membrane, that is primary unit of construction of this exchanger. This paper shows problematics of low humidity of air in internal environment with forced ventilation during winter season. Thanks to properties of enthalpy exchanger is possible to achieve sufficient humidity of air in internal environment without necessity of other equipment.

# Multiple Aspects of Comparing Surface Properties of Ceramic Tiles Regarding Slip Resistance

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Keywords: Ceramic Tiles, Slip Resistance, Friction, Surface Roughness, Cleanability.

**Abstract.** The objective of this study was to determine the affecting factors that can possibly change slipperiness of flooring. Laboratory slip resistance tests were conducted under different surface conditions. Two different methods were used to measure 6 different ceramic tiles. This article has its focus mainly on the required security and its quantification during the service life of floor coverings. Slip resistance of ceramic tiling can change with use. It is worth to investigate the effect of cleaning agents on slipperiness of floors, because it could be more dangerous when the cleaning process is in progress, so the surface is still in wet state or partly covered by liquid. This paper makes a comparative analysis on the different measurement methods and sliders that rub against the surface. In case of public and residential buildings slip resistance and surface roughness associated with cleanability, all have influence on safety in use and durability. The results showed that the perceived surface roughness parameters could be used as indicator of slipperiness and supplement objective measurement of this performance.

# The Economic Analysis of Building Structures with Fair-Faced Self-Cleaning Concrete

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Keywords: Self-cleaning concrete, fair-faced concrete, titanium dioxide, construction cost, cost analysis.

Abstract. The study presented in the paper deals with fair-faced concrete having a self-cleaning effect. This effect is induced by photo catalytic forms of titanium dioxide (TiO<sub>2</sub>) in concrete. The characteristics of TiO<sub>2</sub>, its production and application in construction are discussed in the paper. The economic analysis of building structures with fair-faced self-cleaning concrete is intend to point out that despite higher costs on such concrete production, its durability is longer compared to conventional concrete. The economic analysis is aimed at estimation of costs on self-cleaning fair-faced structures with smooth and textured finish facade area.

# Design and Numerical Modelling of Prefabricated Roller Blind Lintels

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Keywords: Roller blind lintel, window, masonry, static, thermal, analysis, FEA.

**Abstract.** The prefabricated roller blind lintels have become common solution, particularly for the single-leaf masonry structures without external thermal insulation system. These lintels, representing simple system solution, are designed to interrupt thermal bridges in a place of above the window lintel and simultaneously to provide sufficient reliability of load transfer. The actual outdoor blinds contribute to increase the thermal stability in the room in summer and winter season. They prevent overheating of the room in the summer months and reduce heat transmission through a window in the winter. This paper is focused on the design and numerical modelling of the prefabricated roller blind carrier lintels solutions. Methods of elimination of the thermal bridge are demonstrated on the example of a real produced prefabricated lintel. At the same time this paper deals with its structural analysis. Analyses were carried out using the method of numerical modelling, using finite element method and computing software ANSYS.

# Fire safety of apartment buildings fabricated from glued sandwich panels

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Keywords: fire safety of buildings, timber structures, light buildings.

Abstract. At present, the trend in new building techniques is to move towards light construction systems, and efforts are also being made to use such techniques with multi-storey buildings. It is a characteristic of the Light Building construction system that a substantial part of the structure of a building is made up of thermal insulation, and heavy and wet processes are eliminated. The article focuses on the options for the use of a specific new technique which utilizes the advantages of large-format construction panels composed of 15 mm thick wood chipboard cladding glued using a polyurethane adhesive directly onto rigid thermal insulation, which is most frequently made from façade polystyrene. No other reinforcement is used. The consistency and load-bearing capacity of the panels are exclusively provided by the gluing of the insulation to the cladding using a polyurethane adhesive. The contribution focuses on the prospects for the use of this interesting technique from the aspect of the fire safety of apartment buildings; so far it has only been used for family homes. The contribution also contains a comparison of construction-related technical and financial indicators of use of this technique with standard construction systems employed for timber structures and also with traditional ceramic masonry from the viewpoint of the fire resistance of individual structures.

#### Problems in the Designing of Acoustic Properties of Musical Rehearsals

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**Keywords:** acoustic microclimate, musical rehearsal, musical laboratory, reverberation time, absorption material surface

**Abstract.** Content of the post is to describe the creation of building structures, typology, internal environment, and internal wall coverings music rehearsal for optimal acoustic performance. One of the aspects of its internal environment is reverberation time. For this variable there are several methods of calculation. Article gives an indication of how the music was the laboratory building in the center of the music created and what problems the authors in its proposal met. Article contents and solving spatial and building acoustics model music musical rehearsal building downtown. Calculation fully respects Slovak standards valid for the design of room acoustics, as well as hygiene regulations on noise pollution. Acoustically treated room should serve as a laboratory for musical performance. If the building is more proof is needed to solve the sound insulation (building acoustics) that these areas do not interfere with each other. In addressing acoustics of testing can't talk about bad or good acoustics, but rather on the season and out of corresponding with room acoustics, respectively, with activities in it.

#### Case study of the straw bale house

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Keywords: straw, straw bale house, specific heat use for space heating

**Abstract.** Straw is renewable material both from the ecological and environmental point of view. It is almost always available at construction places. Straw is used mainly as filling thermal insulation material in structures. This paper deals with design of a two-generation family house. The family house is located in the north-eastern part of Slovakia, where external design temperature is -16 °C. The objective of this paper is to achieve specific heat use for heating lower than 15 kWh.m<sup>-2</sup>.a<sup>-1</sup>. Specific heat use has been calculated according to STN EN ISO 13 790 Energy performance of buildings. The paper analyses forced ventilation with the unit for recovery of heat, orientation towards cardinal points, filling structures, ratio of glazed and solid surfaces of the designed house and their impact on energy performance of buildings. Individual parameters are mutually combined, and required objective has been achieved.

#### Improving the Impact Sound Insulation of an Existing and Refurbished Wooden Beam Floor Construction

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**Keywords:** Impact Sound Insulation, Impact Sound Pressure Level, Renovation, Refurbished, Wooden Beam Floor, Building Acoustics, "Gründerzeit" Buildings.

**Abstract.** A common source of dissatisfaction in buildings pertains to acoustical issues. Specifically, in existing buildings, exposure to impact noise represents a frequent problem. In Central Europe generally, and in Vienna (Austria) specifically, there is a significant number of existing buildings with floor constructions involving wooden beams as structural elements. Given the steady rise in inhabitants' expectations regarding buildings' acoustical quality, such existing floor constructions do not sufficiently provide the sufficient impact noise insulation. In many instances, the replacement of these floor constructions with concrete slabs is not an option, given a number of structural, financial, and legal (conservation related) obstacles and constructions with wooden beams by using modern materials and techniques. Toward this end, a typical 19<sup>th</sup> century building in Vienna downtown was selected. Multiple improvement options were realized. These involved the deployment of a honey-comb acoustic system, installation of stiffeners bolted to the original wooden beams, as well as an additional structurally decoupled ceiling layer. The impact sound was measured at different stages of retrofit and compared with the performance of the original construction.

### Optimization of Mineral Dry-shake Topping Dosage in Industrial Concrete Floors with Respect to Selected Quality Parameters

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**Keywords:** Industrial Floor, Mineral Dry-Shake Topping, Abrasion Resistance, Absorbing Power, Cohesion.

**Abstract.** For the final quality of the industrial floors with mineral dry-shake toppings is a decisive factor amount of the mineral dry-shake topping in the course of its implementation. Amount of the mineral dry-shake topping affects mainly on the abrasion resistance, which is critical for the real life of the floor. Another important property is the absorbability of the finished floor and mineral shake-layer coherence with the concrete base. This paper summarizes a study on the ideal amount of mineral dry shake toppings when considering the resulting wear resistance of floor surface finish as well as its water absorption and also the adhesion properties of the studied layer to the concrete base.
#### CFD Model of Thermal Plume Occuring above Hot Surface of Kitchen Appliance

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Keywords: Thermal Plume, Kitchen, CFD Simulation.

**Abstract.** During the cooking process, pollutant fumes are released into the ambient air by the convection plumes. These convective plumes - thermal plumes – are generated above hot surfaces and they need to be efficiently and ecologically ventilated in order to achieve appropriate internal climate. Calculation method for determination of volume flow rate of rising convective plumes is described in German standard DIN 18869 [1]. This article focuses on study of thermal plumes using numerical model in software Ansys Fluent, determinates volume flow rate of rising air and compares the simulation results with the results from known computational relations.

#### Modelling of Daylight Sources in the Artificial Sky

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**Keywords:** Daylighting, Daylight Sources, Artificial Sky, Calibration of Artificial Sky, CIE General Standard Sky.

Abstract. Daylight in nature is characterized by daily permanent changes of sunlight and skylight. Real measurements of daylight availability are showing that different daylight exterior illuminance for building interiors can be expected each minute. This brings some complications in the window design and the choice of criteria for daylight evaluations. There are several ways how to find basic conditions and typical relations combining sunlight beam with diffuse skylight from the whole sky vault. The older assumption considered that interiors have to be sufficiently illuminated under the worst overcast conditions. The newer approach is based on the utilization of daylight in specific localities and the determination of changes in sunlight and skylight occurrence probability. Therefore, both daylight sources are researched in detail specifying sky luminance distributions and sun influences to find conditions for their simulation in laboratory facilities. The most sophisticated equipment to study daylighting in exterior and interior architectural spaces are artificial skies with the artificial sun. These have to be precisely calibrated with a verified zenith luminance and horizontal illuminance levels by theoretical calculations and checked by experimental measurements. Reference daylight conditions defined in the ISO/CIE 15469:2004 standard have to be respected with trials to determine natural sun and sky as sources of daylight in the real environment and modelling these in the artificial sky in a certain intensity scale. This paper presents the method and results of modelling daylight applying electrical light sources in artificial sky which is installed in the Institute of Construction and Architecture, Slovak Academy of Sciences (ICA SAS) and discusses possibilities of their simulation in laboratory conditions.

### Material Optimization of Wooden Window Structures to Increase Their Thermal Properties

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Keywords: Wood, Windows, Thermal Properties, Optimization.

**Abstract:** This contribution is dedicated to an alternative solution of wooden window structure in order to achieve better thermal properties. The proposed window with a sandwich material composition will conform to the requirement of the norm STN 730540 valid from the year 2016. Subsequently, production technology of the given structure will be described.

#### Calibration method of Cool Box used for Measuring of Thermal Conductivity Coefficient

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Keywords: cool box, calibration, thermal conductivity coefficient, guarded hot box

Abstract. One of the method used for determining the thermal conductivity coefficient of building materials is the Calibrated and Guarded Hot Box method. This method is based on the principle of measuring the heat flux density that passes through the test specimen at a temperature difference between warm and cool parts of the measuring box. For measuring of Thermal Conductivity Coefficient is at the Faculty of Civil Engineering of VŠB-TUO uses the Cool Box. Measuring in Cool Box uses the same principle of measuring as Calibrated and Guarded Hot Box. For creating temperature difference during the measurements at the Cool Box is not used heat, but cold. Measurement of the Thermal Conductivity Coefficient by a Cool Box is very complex in terms of measurement accuracy. That the resulting values as accurate as possible, it is necessary to calibrate itself refrigerated cabinets and all sensors that are used for measurements. This paper describes the principles of calibration of Cool Box and other components, which are used for measuring the Thermal Conductivity Coefficient of selected natural building materials. Determination of the thermal insulation properties of selected materials is part of a long-term research focused on conventional and unconventional natural building materials.

#### **Glazing with Low-Emissivity Layers and its Performance Simulation**

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Keywords. Low-Emissivity Layer, Surface Emissivity, Glass, Performance Simulation.

**Abstract.** The contribution deals with the importance of low-emissivity glazing layers in improving the energy balance of building interiors. It describes the effects of changes in surface emissivity of glass, depending on the position of low-emissivity layer. It also discusses principles, advantages and disadvantages of the most common glazing combinations with regard to interior visual and thermal comfort and also slightly misleading interpretations caused by complexity of the matter. The discussion (and comparison) is based on methods and tools used in computer-aided building performance modelling and simulation and on recent information from glass industry..

## Analysis of Fire Protection With Focuse on the Specific Conditions of the Historic Roofs

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Keywords: Wood Truss, Sprinkler, Firefighting Arrangements, Inhabited Area, Cultural Heritage.

**Abstract.** Protecting of historic roofs is an important part of efforts to protect our cultural heritage. These wooden structures carry a lot of information about the authentic tools, technologies and construction processes. Trusses are generally endangered by many risks that could cause irrecoverable damage and loss of information. In addition to the threat wood destroying insect and fungi, should not be forgotten on fire threats that may start from lightning, through electrical installations, to the burning of the surrounding dry grass areas. Historical wooden trusses are with respect to the old wood, indoor climate, the unavailability or the fact that many national cultural monuments are located outside of the inhabited territories, very susceptible to fires. Nevertheless, there are many methods, which are used for new buildings, but unusable for historical truss, and others were proved to be unsuitable by the time. This article analyses the possibilities of modern firefighting arrangements in the historic truss with regard to the specific construction conditions and with regard to the very rare substructure, which should not be damaged.

### Evaluation of the Dependence of the Parameters of Internal Environment of Wooden Truss on the Orientation of the Building

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**Keywords:** Relative Humidity, Wood Moisture, Fungi, Wood-Destroying Insect, Cultural Heritage, Historical Wooden Truss.

**Abstract.** Historical wooden trusses carry a lot of information about used tools, technologies or construction processes. Unfortunately they are generally threatened by many dangers, which could cause irreparable damage and loss of the carried information. Protection of historical roof trusses is an important part of efforts to protect our cultural heritage. Wood destroying insects and fungi are the most serious threats to historical roof trusses in our climatic conditions. Their spreading depends on several specific (interior) conditions. These include critical moisture content in the wood, relative humidity, temperature, etc. In addition to these commonly monitored parameters (and their critical levels) we also must not forget the influence of local geography, biotope or orientation to the cardinal. This paper describes temporal fluctuations of some of the mentioned physical parameters in a historical roof truss (in Brno, Czech Republic) with regard to external climatic conditions and orientation to the cardinal.

#### **Building Monitoring and Diagnostics: A Web-Based Approach**

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**Keywords:** Building monitoring, building performance, building diagnostic, data analysis, embedded systems.

Abstract. Efforts toward optimized building management and operation require monitoring data from multiple sources. Experiences from previous research projects underline the need for an easily adaptable, low-cost, and easy to set up monitoring infrastructure that could provide data for modeling and performance evaluation. The increasing availability of small and powerful development boards (e.g. raspberry, beagleboard or arduino) facilitates the implementation of a cost-efficient infrastructure for data collection and building monitoring. For the purpose of the present contribution, the Arduino Yún was used to create a data logger that obtains data from wireless sensors, stores it locally, and syncs it with a data repository. Toward this end, we have developed a web-based user interface that enables the user to evaluate various aspects of the monitored building's performance. The communication between the software components is implemented via RESTful interfaces and enables the user to integrate also other data sources such as web services. The paper includes an actual implementation of the above approach. Thereby, we illustrate how the constitutive system components can be integrated in terms of a versatile monitoring system with multiple utilities in terms of building performance assessment and building diagnostics.

#### Comparison Between Dynamic and Static Metrics for Daylight Evaluation in the Case of Obstructed Buildings

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**Keywords:** Daylighting, Dynamic Daylight Performance Metrics, Static Daylight Performance Metrics, Useful Daylight Illuminance, UDI, Daylight Factor, Daysim, Climate-Based Daylight Modelling.

**Abstract.** Daylight in buildings can be evaluated using dynamic and static daylight metrics. The daylight factor is a static daylight metric which evaluates daylight conditions under the overcast sky model according to the International Commission on Illumination. However, the dynamic daylight metrics (e.g. daylight autonomy, spatial daylight autonomy, useful daylight illuminance) can be more complex evaluation criteria because they are based on annual daylight illuminance data for a building site. While the daylight factor value depends only on a room geometry, optical properties of surfaces and positioning of daylight obstructions, the dynamic daylight metrics also include an effect of a building location, window orientation or building occupancy pattern. The article deals with a comparison of a daylight evaluation using dynamic and static daylight metrics in the case of buildings whose daylight is obstructed by external barriers.

#### Environmental Simulations and Their Role in the Research of Human Responses to Environmental Stimuli

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**Keywords:** Environmental Simulation, Web Application, Material, Environmental Setting, Colour, Surface, Preferences, User, Virtual Reality.

**Abstract.** The paper is aimed at the problematics of environmental simulations as one of the efficient methods of behavioural research for exploring the reactions of respondents to certain environmental settings. It explores the contemporary situation of the development of simulation at different levels within the environment, serving as visualizations of designed spaces, for games and simulation /testing of subjective and objective responses to different environmental stimuli. In our long-term research at the BCDlab, we are focused on body conscious design, which means exploring relationships: body/nervous system and the environment with an aim to design human friendly solutions through spatial design. To gain our own experiences with environmental simulation, BCD-APP, which works as a web interface and also in virtual reality. The paper presents the process of setting research methods and results of the first pilot tests of the app as a research tool, with a small controlled group of respondents. They were confronted with pre-selected settings of materials, colours and surface finishing, and with the setting of their own choice, the subjective and objective physiological reactions (brain waves and respiration) were measured by EEG sensors and evaluated in a Labchart environment.

#### Grate-Free Ventilated Thermal Insulation Systems

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**Keywords:** reconstruction, composition of circuit design, substrate moisture, humidity masonry, uneven surface, ventilated thermal insulation, thermal transmittance, mineral - stone wool, hard plate, grate-free mounting plate, special plate anchor price, the entire system, fire resistant, ventilated space, ruggedness.

**Abstract.** Grate-free ventilated thermal insulation systems. Description of the using a complex system grate-free aerated insulation of buildings using plate anchors "michno-system" and Gigapan boards. This is a new way of insulation, which will be financially viable for a wide range of buildings. The system responds to common problems with traditional contact system. These are primarily the effect that the house called "breathe", then there will not be a risk, that the birds will be peck insulation. The system is suitable method for solves the problem of uneven walls for reconstruction, disparate and sometimes wet outer shells of old buildings.

#### Analysis of Energy Sources on Energy Indicators Performance

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Keywords: Energy performance, Energy, Building, Energy classes, CO<sub>2</sub>

Abstract. In the members states of the European Union (EU), portion of buildings in the total consumption of energy represents 40%, and their portion in  $CO_2$  emissions fluctuates around 35%. The EU is trying to protect the environment by reducing energy demand and releasing  $CO_2$  emissions into the air. Energy performance (EP) is the quantity of energy, which is necessary for heating and domestic hot water production, for cooling and ventilation and for lighting. Based on results of EP, individual buildings are classified into energy classes A to G. A global indicator (primary energy) is the decisive factor for final evaluation of the building. The new building must meet minimum requirements for EP, i.e. it must be classified to energy class A1 since 2016, and to energy class A0 since 2020. The paper analyses effect of the use of different resources of heat in a family house designed according to requirements valid since 2020, and its subsequent classification into an energy class.

#### Drying of the Basement Spaces of the Faculty of Arts in Brno

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Keywords: Heating, Frequency, Microwaves, Electromagnetic, Moisture, Wall, Foundation.

**Abstract.** Drying masonry building structures using high-frequency electromagnetic radiation, socalled microwave technology in construction practice is becoming more common. It is an innovative method which can be used to remove excess moisture with significant speed. This article focuses on the description of physical phenomena that occurs during drying and compares the most commonly used processes for drying buildings. This article describes the heating of building materials (basement spaces built from full burnt bricks) using microwave radiation. It assesses the depth of the heating process achieved under different conditions while taking account of various moisture content of irradiated material and varied length of heating.

#### Economic Analysis of Energy Saving Measures in Current Prefabricated Panel Buildings

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**Keywords:** Prefabricated panel buildings, energy consumption, energy saving measures, investment costs, operational costs, operational savings, economic return on investment.

**Abstract.** The paper focuses on analysis and assessment of economic effectivity of measures taken in order to lower energy demands of prefabricated panel residential buildings. For this purpose, a group of buildings with previously made modifications with potential to lower the energy and heating consumption were selected. Next, the development of their energy consumption and their costs was monitored. The assessment of achieved figures was made with regards to amount of costs which were paid for these measures and also with regards to their service life, amount of gained subsidy and decrease of consumed energies and operational costs of the buildings after the measures were taken. It was found that there had been a significant difference in investment returns for constituent technical measures. For some of them, it is not even realistic to expect reaching the return of investments during their service life period.

#### Facility Management in Sustainable Building Construction

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**Keywords:** Facility management, sustainable building construction, optimization of buildings, operational costs, energy efficiency, quality of indoor environment, BIM.

**Abstract.** The aim of the paper is to analyse the demands on design and management of modern buildings. Namely, it is the assessment of benefits of facility manager's role in various stages of building's preparation and life cycle. The requirements on production quality, technical equipment and operational efficiency are getting stricter and stricter. Growing demand for energetic efficiency and quality of indoor environment are being analysed together with flexibility and usefulness of modern buildings, including their administration. The analysis of indoor environment quality assessment was carried out by the users of selected modern buildings in relationship to the manner of their management and maintenance. Next, the paper discusses the benefits of facility management not only during the actual using of the modern buildings but also during the project preparation phase in order to meet the users' and owner's requirements.

#### Effect of the Moisture in the Heat Storage Capacity of Building Structures

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Keywords: Building Structures, Moisture, Heat Storage Capacity

Abstract. Buildings in Europe, account for about 20–40% of total final energy consumption. Therefore reduction of energy demand is crucial. It has become one of the most important issues to achieve energy saving at installations and refurbishments of buildings. Humidity in the wall structure of buildings produced by precipitate and other circumstances could modify the building's heat capacity, the heat transfer coefficient furthermore density and/or other factors. In this study, wall structures of buildings with nearly zero net energy consumption were examined that were built from different materials with different moisture load. By applying different experiments and calculations we presented the changes of the stored heat energy of different wall structures in relation to the duration of the building and the outdoor environment. From the perspective of sorption and heat capacity, knowledge of the behavior of structures in relation to their moisture content, can help us to select the perfect type of wall. We have found three major traits peculiar to the change in the stored heat of different building structures in relation to the moisture load.

#### Cooling and Thermal Insulating Effects in Layers of Roof Garden

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**Keywords:** Intensive Green Roof, Roof Garden, Permitivity, Cooling Effect, Thermal Insulation Effect, Photosythesis, Transpiration.

**Abstract.** This paper presents partial results of measurements in the layers of roof garden in winter and summer. On hot summer days, the roof garden can considerably reduce the heat flux through the roof. The largest share of the energy savings in the summer is from transpiration or the evaporation of water from plant leaves. Transpiration cools the surrounding air, thus lowering the temperature of the surface of the soil. In winter, the roof garden acts as additional insulator for buildings, reducing energy needed to provide heating. Layer of soil on intensive vegetative roof in the winter can considerably reduce daily temperature fluctuations.

# The Influence of Internal Coloured Surfaces on the Circadian Efficiency of Indoor Daylight

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**Keywords:** spectral characteristics of daylight, spectral transmittance, circadian system, experiment in situ.

Abstract. The discovery of circadian stimulation by daylight has changed our understanding of the important effect the daylight has on our health and wellbeing. The new medical facts that emerged during the last decade have proven that a long-term absence of circadian light stimulation may be associated with sleep disturbance, tiredness and increased incidence of chronic depression, bipolar disorder, and seasonal affective disorder. The reason is the difference between the visual and biological (circadian) response to light and how it is being perceived by human beings: while the visual perception represented by the luminous efficiency function peaks at the wavelength of 555 nm, the circadian photoreception curve peaks in the blue light spectrum at ~450 nm. The primary circadian stimulation by daylight depends on the properties of light impinging on the retina. An experimental study was designed to quantify the effect of internal coloured surfaces on our circadian stimulation by daylight. Four identical models of a standard office were manufactured, equipped by wallpapers of different colours, and exposed to daylight. Illuminance and spectral distribution of light were measured at different positions along the room and the potential circadian stimulation was evaluated by an established model. The measurements have proven that although the visual comfort may be satisfactory, circadian stimulation may be inhibited, especially when room's surfaces are yellow. Thus, proper choice of internal surfaces' colours is important to prevent the potential negative health consequences.

#### Double Skin Facades with Natural Ventilation Capability: A Case Study of Acoustical Enhancement via Passive and Active (Noise Cancelling) Methods

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**Keywords:** Double skin facades, noise control, natural ventilation, sound insulation, active noise cancelling.

**Abstract.** Within an ongoing project, we explore the potential of double skin facades to provide both noise control and natural ventilation capability. Three strategies are investigated: i) Manipulation of sound paths via offset of the openings in the two shells of the façade; ii) Application of absorbing materials in the interstitial space of the façade; iii) Active noise cancelling methods utilizing wave-destructive interference. This contribution describes the overall project but focuses primarily on the active noise cancellation approach. Aside from a comprehensive background research on existing technology, we undertook the design of an actual setting for noise cancellation testing with suitable low-cost components as a proof-of-concept. Results of the experiments are expected to inform subsequent efforts to include noise-cancelling technology in double skin facades.