

DUŠAN KATUNSKÝ, MARTIN LOPUŠNIAK,  
MIROSLAV BAGONA, CLAYTON STONE\*

## MONITORING *IN SITU* AND EXPERIMENTAL LABORATORY PHYSICAL ASPECTS OF BUILDING SKINS

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### MONITORING *IN SITU* A EKSPERYMENTALNE LABORATORYJNE ASPEKTY FIZYCZNE POWŁOK BUDOWLANYCH

#### Abstract

This paper shows the profile of the research project: “The centre for excellent research on progressive building structures, materials and technologies”. The objective of this project is: “To support the excellent research of structures for smart buildings, particularly those orientated at the quality of life through energy efficiency and environmental acceptability.

*Keywords: envelope structures, building skins, monitoring in situ, laboratory physical aspects*

#### Streszczenie

Artykuł niniejszy zawiera charakterystykę projektu badawczego: „Ośrodek badania progresywnych struktur, materiałów i technologii budowlanych”. Celem tego projektu jest: „Wspieranie badania struktur budynków inteligentnych, szczególnie nastawionych na wysoką jakość życia poprzez wydajność energetyczną oraz dopuszczalność środowiskową”.

*Słowa kluczowe: struktury koperty, osłony budynku, monitoring in situ, laboratorium fizyczne*

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\* Prof. CSc. Eng. Dušan Katunský, PhD. Eng. Martin Lopušniak, PhD. Eng. Miloslav Bagoňa, Eng. Clayton Stone, Institute of Architectural Engineering, Faculty of Civil Engineering, Technical University of Košice.

## 1. Introduction

The research is based on a centre that encourages integrated research of advanced building structures, materials, and technologies that was in continuous operation from 2009 – 2011.

It consisted of four specific objectives, one of them is:

- Specific objective 2: The support of excellent research for the construction of smart buildings, particularly orientated to the quality of life through energy efficiency and environmental acceptability

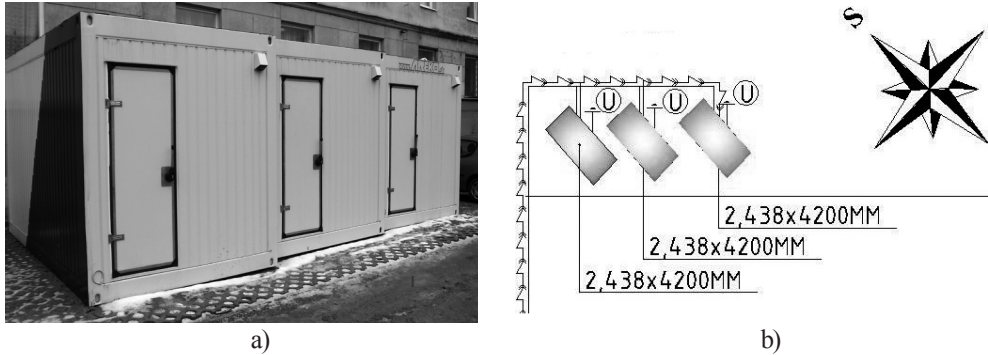


Fig. 1. Monitoring boxes – a) view and b) layout situation

Rys. 1. Kabiny monitoringowe – a) widok; b) położenie

Based on the experience of the initial project the ITMS project is currently focusing on: “A centre for excellent research of progressive building construction materials and technologies” with a solution interval ranging from 2011-2013. It incorporates the following specific objectives.

- Specific objective 1: Load-bearing system for static-dynamic and fatigue testing of bearing structures
- Specific objective 2: Researching the interaction of physical, chemical and biological components of structures and their respective building environments.
- Specific objective 3: To support the research of sustainable building materials
- Specific objective 4: Laboratory of digital research for building structures using virtual reality

## 2. Test equipment for the evaluation of envelope structures in real conditions in situ

The test equipment for the research of progressive building envelopes involves a device that monitors the physical properties of building envelopes, their elements and details in an internal environment, subjected to an indoor quasi - stationary hydrothermal state, and outdoor climatic fluctuations. This is an experimental study of the properties of advanced building constructions and the effects influenced by variable impacts from the external climate.

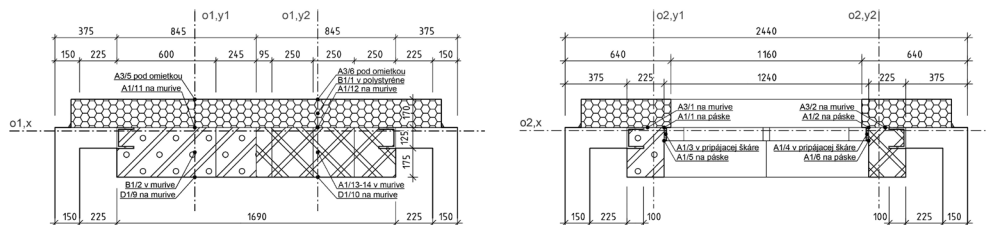


Fig. 2. Details of envelope structure testing

Rys. 2. Szczegółowy test struktur otulinowych

The construction of the proposed monitoring chambers were designed and realized to evaluate the structural, physical and real world requirements for buildings **in operation**. They take into consideration external climatic factors **to maintain** a so-called quasi-stationary state of the internal environment in an experimental model.

Test chambers, which house sample elements of structural elements, are each divided into two parts. One part maintains a constant **hydrothermal** microclimate, while the second part houses the instrumentation devices.

Chambers are capable of monitoring the physical properties of vertical, horizontal or inclined samples which are installed so that they separate the two chambers. Required physical data is tracked and recorded using a fully automatic logger with sensors and computing devices. A meteorological information exchange system is implemented to carry out an annual test.

### 2.1. Test equipment – progressive system of engineering environments

Activity 2.1 consists of the test equipment and an experimental model of a smart building with an advanced indoor environment system. This test device monitors the indoor environment, using advanced systems of heating / cooling ventilation and air conditioning in buildings, and incorporates the dynamics of stored energy in the building structure without adversely effecting internal hygiene requirements, all of which are effected by external variable climatic actions.

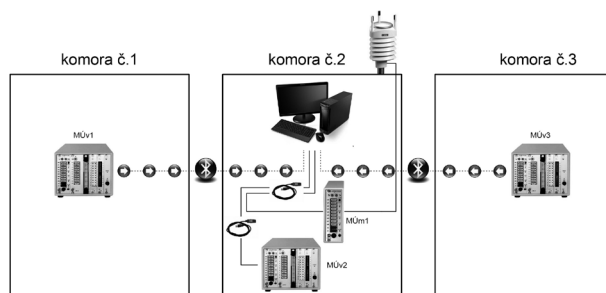


Fig. 3. Equipment interaction between chambers 1,2,3

Rys. 3. Połączenia między komorami 1,2,3

This research aims to improve the quality of integrated research of advanced indoor technologies, with respect to the creation and evaluation of structural components designed for creating progressive building envelopes in conjunction with technical equipment and their impact on a suitable internal environment of a building.

The idea was to create a facility for researching constructions and indoor technologies for progressive and smart building structures. Activity 2 relates to a device that enables the simulation of thermal humidity processes occurring in rooms equipped with progressive HVAC systems (heating / cooling, ventilation and air conditioning in combination with renewable energy sources) through the continuous monitoring of microclimatic conditions and environmental loads imposed on a buildings' indoor environment.

### 3. Evaluation under laboratory conditions

The solution of specific objective 2: Research of the interaction of physical, chemical and biological components of the construction and its building environments are conducive to improving the quality of integrated research for a given architectural environment; with special focus placed on experimental testing of the determinants of environmentally friendly and energy efficient buildings in relation to the use of appropriate building materials, constructions and environmental technology systems. Experimental test chambers known as “house in house” are implemented in an experimental laboratory research test. Here, the evaluation of physical, chemical and biological requirements and other characteristics of structures, materials and technologies in simulated laboratory conditions **will be** simulated to reveal the impact those external climatic factors and internal conditions **for induction** have on both the stationary state of the internal environment and the dynamic state of the external environment in an experimental model.

A laboratory testing chamber known as the “Indoor Stand” – will later verify the **interoperability** of physical properties of building structures; indoor technologies for physical, chemical and biological components of indoor environments which actively monitor operational elements. These elements record data of instantaneous loads induced by physical, chemical and biological components of the internal environment to determine the physical characteristics of structures, in conjunction with a device to monitor changes in **heat-relaxing** and humidity effects of the internal environment.

This device is specifically intended for experimental laboratory research and is designed to illustrate the physical qualities of building structures (envelope and transparent structures) including indoor technologies to determine their effect on the interaction of physical, chemical and biological loads placed on the internal environment of buildings intended for human residence. This information will be used for assessing modifications of structural or HVAC elements.

### 4. Conclusions

Research of new progressive building constructions with the possibility of long-term assessment through monitoring changes in their physical properties are affected by:

- Changing external physical climatic factors and conditions
- A stationary indoor environment, based on the integration of the results and knowledge learned from theoretical solutions and in situ experimental measurement tests.

Further research which is already underway aims to design and construct a prototype climate chamber for testing the physical properties of building envelope elements in experimental laboratory conditions that simulate various geographical conditions. The realization of the Indoor stand will monitor:

- The **hydrothermal** properties of structures their fragments and their details
- The interaction of all components of the internal environment in either cold or hot chambers.

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