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ENVIRONMENTAL ASSESSMENT OF BUILDINGS IN SLOVAKIA

Environmental building assessment is a specific complex of proceedings oriented towards systematic and objective evaluation of building performance. These processes lead to design, construction and operation of buildings with respect to criteria for sustainable development. In the recent years the evaluation of building performance in terms of environmental, social and economic aspects is a discussed topic in the Slovak Republic. The purposes of building assessments from these aspects are due to the determination of real building states from a safety and reliability point of view, the possibility of building comparisons, the effect of environmental buildings potential and the proposal of measures resulting in sustainable buildings. In Slovakia the building environmental assessment system (BEAS) has been developed at the Institute of Environmental Engineering, Technical University of Košice. The proposal of BEAS applicable in the condition of the Slovak Republic will be presented in this paper.

Keywords: building environmental assessment, sustainable development, building environmental assessment system (BEAS)

INTRODUCTION

Building energy consumption comprises approximately 40% of an industrial nation's total energy consumption [1], [2] and [3] leading to the respective emissions. A recent EU directive defines ambitious goals for reducing energy consumption and greenhouse gas emissions and requires all buildings constructed in 2020 or later to be "nearly zero-energy buildings" [4]. The 21st century is the century of global climatic changes and the key criterion for secondary market materials utilization has to be their environmental impact [5]. This calls for performance-oriented building design, aiming to develop economically feasible design configurations that have low resource consumption. To achieve significant improvement, a key factor is using the appropriate building modeling methods, considering the relevant engineering interdependencies, especially in early phases, to support the design process and the involved design experts. Sustainable building design requires considering the geometric and visual properties of the design as well as the physical, technical, and economic engineering interdependencies that determine the building's performance [6]. In assessing the performance of buildings, the scope of environmental evaluation

is widening, marking an evolution from consideration of a single criterion, like the economic performance of buildings, towards a full integration of all aspects emerging during the lifetime of a building and its elements [7, 8].

1. ENVIRONMENTAL ASSESSMENT OF BUILDINGS

Since 1990s, there has been extensive development of environmental building assessment methods, many of which have subsequently gained considerable success [9-13]. The Building Research Establishment Assessment Method (BREEAM) was the first real attempt and various schemes such as Sustainable Building Tool (SBTool), Leadership in Energy and Environmental Design (LEED) and Comprehensive Assessment System for Building Environment Efficiency (CASBEE) have subsequently emerged [13].

Almost all environmental assessment methods have been designed to suit a specific territory. Evidence suggests [13-17] that existing environmental assessment methods were developed for different local purposes, and are not fully applicable to all regions. More specifically, certain environmental factors may hinder the direct use of any existing environmental assessment. Examples of such factors are as follows:

- ✓ climatic conditions;
- ✓ geographical characteristics;
- ✓ potential for renewable energy gain;
- ✓ resource consumption (such as water and energy);
- ✓ construction materials and techniques used;
- ✓ building stocks;
- ✓ government policy and regulation;
- ✓ appreciation of historic value;
- ✓ population growth;
- ✓ public awareness [13].

By integrating the building with the site in a manner that minimizes the impact on natural resources, we can maximize human comfort and social connections. The development footprint should enhance the existing biodiversity and ecology of the site by strengthening the existing natural site patterns and making connections to the surrounding site [18].

2. ENVIRONMENTAL ASSSESSMENT OF BUILDINGS

In recent years the evaluation of building performance in terms of environmental, social and economic aspects has become a topic of discussion in the Slovak Republic, as well. This topic is often discussed by architects, designers and developers. The new building environmental assessment system (BEAS) has been developed at the Institute of Environmental Engineering of the Technical University of Košice.

The systems and tools used in many countries have been the foundation of the new system development applicable under Slovak conditions, mainly the SBTool. The BEAS has been developed for the preliminary stages of the life cycle, i.e. pre-design and design. This system contains six main fields and 52 indicators. The main fields and determining indicators of BEAS are based on the available information analysis from particular fields and also on one's own experimental experience. The proposed fields and indicators respect and adhere to Slovak standards, rules, studies and experiments.

The methodology of the derivation of assessment field in BEAS has been performed according to a study [19]. A field list has been derived by a three-step process. In order to establish a comprehensive set of fields of the environmental building assessment method for office buildings, a combination of reviewing existing methods of environmental building assessment used worldwide, valid Slovak standards and codes, and an academic research paper has been conducted. A three-step process has been conducted in this method. The first step, a full range of fields relating to the sustainable building efficiency, has been collected through a wide-ranging literature review. In step 2, a draft field list has been selected from the full field list based on an in-depth analysis. In step 3, a questionnaire survey has been conducted in order to get the expert comments to refine the draft fields.

As a result, a final list of fields has been proposed:

In the first main field marked as A - Site Selection and Project Planning - there are assessed site selection, project planning, urban design and site development (21.34%). In the second main field marked B - Building Construction - there are assessed materials, LCA and energy flows (14.54%). In the third main assessment field marked as C - Indoor Environment - there are assessed thermal comfort, humidity, acoustic, daylighting, TVOC, indoor air quality, radon, NO_x, PM10 and microbe (22.52%). In next main field marked as D - Energy Performance - there are assessed: operation energy, active systems for using renewable energy sources and energy maintaining (27.84%). In the main field marked as E - Water Management - are assessed reduction and regulation water flow, surface water run-off, drinking water supply and using filtration "grey water" (7.8%). In the last main field marked as F - Waste Management - there are assessed plan of waste disposal and waste minimalization (5.59%).

2.1. Office buildings assessment

The aim of this paper is the assessment of selected nine office buildings situated in the east of Slovakia for the purpose of system verification. The evaluated office buildings were assessed in the phase of design according to available documentations, mainly drawings. The assessment was performed by software tool for BEAS prepared in MS Excel. Office building marked as 1 is located in Snina, 2 is located in Spišská Nová Ves, 3 is located in Košice, 4 is located in Michalovce, 5 is located in Bardejov, office buildings marked as 6-7 and 9 are located in Košice, office build-

ing marked as 8 is located in Bardejov. Environmental regionalization of Slovakia represents a cross-sectional source of information on the state of environment and reflects differentiated state of environment in various parts of the country. Regions show varying degree of individual environmental loads and different risk factors. These impacts, loads, or hazards present mainly anthropogenic characteristics. The process of environmental regional classification marks regions of certain quality or level of endangerment of the environment through analyses of individual components (including the risk factors) of environment as well as partial syntheses within the very component of environment or inter-component syntheses, respectively. One of the final outputs is a map that evaluates the Slovak territory in 5 degrees of quality of environment, which is the basis for identification of areas with the greatest environmental load [20].

2.2. Results of environmental assessment

In Figure 1 there are shown results of environmental assessment of selected nine office buildings situated in the east of Slovakia. In Table 1 there are shown average scores in each main field of assessment.

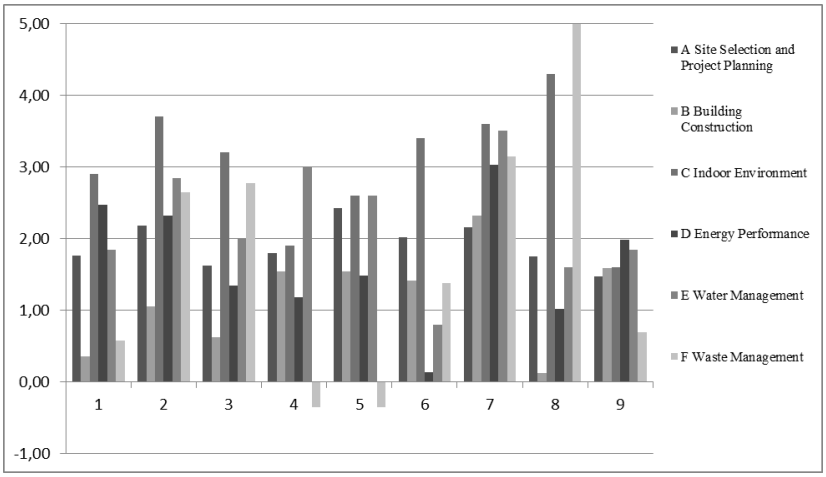

Fig. 1. Results of office buildings assessment

Table 1. **Average scores**

	Main fields	Weighted Score	Active Weights [%]
A	Site Selection and Project Planning	1.91	14.71
B	Building Construction	1.17	20.59
C	Indoor Environment	3.02	23.56
D	Energy Performance	1.66	26.47

E	Water Management	2.23	8.88
F	Waste Management	1.72	5.88
	Total weighted building score	1.04	Environmentally acceptable buildings

The field "Site selection and project planning" obtained average value of 1.91; "Building construction" value of 1.17; "Indoor Environment" value of 3.02; "Energy performance" value of 1.66; "Water management" value of 2.23 and field "Waste management" value of 1.72. The total weighted building score is 1.04 which is classified as "Environmentally acceptable building" on the base of classification key (Table 2). The results from the comprehensive environmental assessment of selected offices can assert that it is necessary to propose measures to improve the environmental suitability and safety of the evaluated office buildings in all assessed fields.

Table 2. **Classification key**

Score	Category
–1	Environmentally unacceptable building
0	Environmentally acceptable building
3	Environmentally friendly building
5	Sustainable building

CONCLUSION

This paper presents the development of a building environmental assessment methodology and system that is intended to assist the design process. The proposed environmental assessment system of buildings applicable in Slovak conditions consists of 6 main fields and 52 relevant indicators. The basis of system development consists of systems and methods used in many countries, especially SBTool. The main fields are building site and project planning, building constructions, indoor environment, energy performance, water and waste management. The proposed fields and indicators respect Slovak standards, rules, studies and experiments. The aim of this paper was also to introduce the proposal and verification of BEAS. The selected office buildings are located in the east of Slovak republic. The average score of assessed buildings is 1.04 which is classified as "Environmentally acceptable building". The theoretical level of present knowledge of building environmental assessment is complete. It is necessary to implement this knowledge to construction practice. The following research work will be aimed at determination of significance weights of indicators. For the purpose of assessment system verification, it is needed to evaluate a statistically significant set of buildings. The results from further system verification will allow modify the significant weights of indicators.

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OCENA ODDZIAŁYWANIA BUDYNKÓW NA ŚRODOWISKO W SŁOWACJI

Ocena oddziaływania budynków na środowisko tworzy szczególny zespół działań ukierunkowanych na systematyczną i obiektywną ocenę budynków. Działania te prowadzą do projektowania, budowy i eksploatacji budynków w odniesieniu do kryteriów zrównoważonego rozwoju. Program oceny oddziaływania budynków na środowisko (BEAS) został opracowany w Słowacji w Instytucie Inżynierii Środowiska Uniwer-sytetu Technicznego w Koszycach. W opracowaniu przedstawiono założenia BEAS stosowane w warunkach Republiki Słowackiej.

Słowa kluczowe: oddziaływanie budynków na środowisko, zrównoważony rozwój, program oceny oddziaływania budynków na środowisko (BEAS)