ENVIRONMENTAL ASSESSMENT OF WATER MANAGEMENT IN NEW BUILDING

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ABSTRACT

Integrated building design should take into account environmental, social and economic dimensions of sustainability. These three dimensions of sustainability are incorporated in systems of building sustainability assessment. An important trend is the increasing number of tools world-wide that aim at making comprehensive environmental assessment of buildings and provide rating for simplified communication. Systems and tools used in many countries were based on the system development for application under Slovak conditions. The building environmental assessment system (BEAS) has been developed in Slovakia as well through the last years. The main fields and indicators of BEAS are proposed on the base of available information analysis from particular fields and also on the base of our experimental experiences. The proposed indicators respect Slovak standards and rules. BEAS as a multi-criteria system is incorporated in proposed main fields: site selection & project planning; building construction; indoor environment; energy performance; water management and waste management. The objective of this paper is evaluation of building in the field of Water Management by system BEAS and also by worldwide preferred system LEED. LEED as green building certification program recognizes best-in-class building strategies and practices. The credit categories are: integrative process, location and transportation, material and resources, water efficiency, energy and atmosphere, sustainable sites, indoor environmental quality, innovation and regional priority credits. The main goal is to analyze and compare the achieved results to determine the appropriate use of various building sustainability assessment systems in the country.

Keywords: sustainable buildings, water management, BEAS, LEED

1. Introduction

Numerous green building assessment methods have been developed all over the world, such as America's Leadership in Energy & Environmental Design (LEED), the UK's Building Research Establishment Environmental Assessment Method (BREEAM), Japan's Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Canada's Green Building Challenge, Netherland's GreenCalc, Australia's NABERS, Hong Kong's HKBEAM, and Germany's DGNB (Yu *et al*. 2015). There are many examples in literature of studies concerning building environment assessment tools (Asdrubali *et al* 2015). The evaluation of the individual systems can be summarized into the following groups: landscape, building construction, energy efficiency, indoor environmental quality, water and waste management. The integrated assessment of buildings is very important in achieving sustainable development. The aim of the building environmental assessment is to provide a sustainable building design, construction, operation, maintenance and renovation, all of which requires cooperation between civil engineers, architects, designers, environmentalists and other experts from different areas of building performance. Sustainable buildings involve taking the entire life cycle of buildings, environmental quality, technical and functional quality, social and cultural factors, economic factors as well as future values all into account.

The aim of this paper is evaluation of building in the design phase in the field of water management by system BEAS and also by worldwide preferred system LEED and to analyse

and compare the achieved results to determine the appropriate use of various building sustainability assessment systems in the country.

The goal of water management is to preserve site watersheds and groundwater aquifers, conserve and reuse storm water, maintain an appropriate level of water quality on the site and in the building, reduce drinking water consumption and to reduce off-site treatment of wastewater. It is known that two of the greater problems of the modern society are the water shortage and the degradation of the environment (Mariolakos, 2007). The increasing demand for sustainable development will have a profound impact on all types of urban infrastructures. However, there is a lack of knowledge of how sustainable development should be attained and how sustainability of various technical systems should be assessed. A set of sustainability criteria covering health and hygiene, social and cultural aspects, environmental aspects, economy and technical considerations are defined. To promote the practical use of a set of sustainability criteria it must be concise and related to quantifiable indicators that are easily measured (Hellstroma *et al*. 2000). The criteria of sustainability are included in building environmental assessment systems used in different countries for evaluating the sustainable and environmental performance. The building environmental assessment systems deal with site selection criteria, the efficient use of energy and water resources during building operations, waste management during construction and operations, indoor environmental quality, demands for transportation services, and the selection of environmentally preferable materials. The objective of this paper is evaluation of building in the field of Water Management by system BEAS and also by worldwide preferred system LEED.

2. Methodologies

The internationally significant system LEED and Slovak building environmental assessment system (BEAS) are used for evaluation of selected family house situated in Košice (Slovakia) namely in the field of water management.

LEED (Leadership in Energy and Environmental Design) was developed and piloted in the U.S. in 1998 as a consensus-based building rating system based on the use of existing building technology. The development of LEED has been through the U.S. Green Building Council member committees. LEED is a third-party certification programme and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health, namely: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. Certification scale in system LEED is Certified, Silver, Gold and Platinum. In table (Table 1) is presented the checklist for the LEED. In the table (Table 2) is shown indicators in field of water efficiency.

Table 1: LEED v4 for Building Design and Construction: Homes and Miltifamily Lowrise.

Main fields	Possible points	Percentage weights [%]
Innovation and Design Process (ID)	11	8.27
Location and Linkages (LL)	7	5.26
Sustainable Sites (SS)	22	16.54
Water Efficiency (WE)	**15**	**11.28**
Energy and Atmosphere (EA)	38	28.57
Materials and Resources (MR)	16	12.03
Indoor Environmental Quality (EQ)	21	15.79
Awareness and Education (AE)	3	2.26
Total	133	100.00

Table 2: LEED v4 for Building – Water Efficiency.

		Possible points	Percentage weights	
Water Efficiency (WE)		15	%	
1. Water Reuse	1.1 Rainwater Harvesting System	4	26.67	3.01
	1.2 Graywater Reuse System	1	6.67	0.75
	1.3 Use of Municipal Recycled Water System	3	20.00	2.26
2. Irrigation System	2.1 High Efficiency Irrigation System	3	20.00	2.26
	2.2 Third Party Inspection	1	6.67	0.75
	2.3 Reduce Overall Irrigation Demand by at Least 45 %	4	26.67	3.01
3. Indoor Water Use	3.1 High-Efficiency Fixtures and Fittings	3	20.00	2.26
	3.2 Very High Efficiency Fixtures and Fittings	6	40.00	4.51

BEAS (Building environmental assessment system) was developed at the Institute of Environmental Engineering, Technical University of Košice. BEAS as a multi-criteria system includes environmental, social and cultural aspects. The main fields and relevant indicators of BEAS have been proposed on the basis of available information analysis from particular field of the building performance in Slovakia and also according to our experimental experience. The fields and indicators in system BEAS respect and adhere to Slovak standards, rules, studies and experiments. The system for Slovakia contains 6 main fields and 52 indicators. Certification scale in system BEAS is environmentally non-acceptable building, environmentally acceptable building, environmentally friendly building and sustainable building. In table (Table 3) is shown system BEAS and in table (Table 4) is shown water management of system BEAS.

Table 3: System BEAS.

Main fields		Percentage weights [%]
A	Building Site and Project Planning	14.71
B	Building Construction	20.59
C	Indoor Environment	23.56
D	Energy Performance	26.47
E	**Water Management**	**8.88**
F	Waste Management	5.88
Total		100

Table 4: BEAS – Water Management.

E	Water Management	8.88 %	
E1	Reduction and regulation of water flow in water systems	42.3 %	3.75 %
E2	Surface water run-off	12.2 %	1.08 %
E3	Drinking water supply	22.7 %	2.02 %
E4	Using filtration “grey water”	22.7 %	2.02 %

3. Environmental assessment of family house

The aim of this paper is to evaluate a selected family house in term of water management. The family house is assessed by LEED and BEAS. Family house is situated in the town of Kosice, part of Krasna. The building is located on slightly sloping terrain near local road. Access to the building is ensured through a local road from two sides of the building - the main entrance to the building is from the north side and the second entrance to terrace is from the west side. The family house has not garage. The house is connected to engineering networks such as electricity and water. House is connected to the public network wiring, water supply and

sanitation. Heating is provided by heat pump air – water as well as masonry heater. House has two floors. On the first floor there are a vestibule, hall with staircase space, living room, dining room, kitchen, two bedrooms, and bathroom with toilet, pantry, boiler room and terrace. On the second floor there are hallway, three children's rooms, bedroom, closet, bathroom, toilet and balcony. All peripheral strip foundations are stored in field grown min. 1000 mm to 1100 mm below the terrain level. Vertical structures - Peripheral masonry is from bricks Porotherm 44 Ti with mineral wool insulation with thickness of 100 mm. Window frames and doors are plastic 5-chamber with Triple glazing. Non-load bearing partition structures are built of brick Porotherm. Horizontal structure - ceiling grid over first floors and second floor is designed as a monolithic reinforced concrete slab with thickness of 180 mm. The ceiling above second floor is insulated plates of mineral wool with thickness of 200 mm. The roof structure - roof construction is a saddle with hip with a slope of 25°. Roofing is paved by Bramac. Internal surfaces - interior wall and ceiling surfaces are fitted with plaster and painting. External surfaces - wall surface forms the outer silicate plaster. Figures 1 illustrate schematic plan view and cross section of family house.

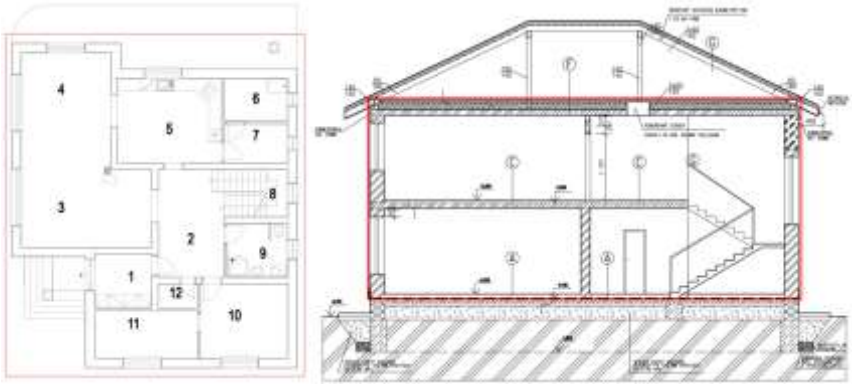

Figure 1: Schematic plan view of the ground floor and schematic sectional view of the object (the red lines presents zone under consideration).

In the assessed family house are high quality facilities designed to reduce and control the flow of water fitting and toilet flushing. The management of surface water is on high level. The family house is supplied enough amount drinking water with high quality. The grey water system is not designed in assessed family house. Rainwater harvesting system used 100 % of roof area. Rainwater is used outdoor only.

4. Results and discussion

Indicators, way of assessment and score are analysed and compared for the evaluation of buildings in the Slovak conditions. In field of water efficiency by system LEED for Homes was achieved only 6 points from 15 possible points (40 %). Final score in field of water management is 3 from 5 point scale by BEAS (60%). In this paper the evaluation of new family house in the field of water management by system BEAS and also by worldwide preferred system LEED is performed for purpose of analyse and compare the achieved results as well as to determine the appropriate use of various building sustainability assessment systems in the given country. The percentage weights of water management in significant environmental assessment systems vary from 2 % to 27.7 %, the lowest significant weight of 2% is for Japanese system CASBEE, UK system BREEAM has 6%, Australian system NABERS has 6.67%, Canadian system Green Globes has 8.5 % and the highest of 27.7% is for Jordan system SABA. Water management in Slovakian system BEAS has percentage weight of 8.88 % and system LEED has percentage weight of 15 %. All those weights the importance reflect national specificities. The guidelines and risk management framework for beneficial and sustainable management of water recycling systems is missing in Slovakia. Many studies (Kaposztasova 2014a, 2014b) deal with use of gray water in Slovakia. Studies pointed out challenges and recommendations to strengthen and

enhance future of alternative water sources, especially grey water research in our conditions. Study (Zelenakova, 2014) contributes to the theme of reuse of rainwater for buildings captured from their rooftops.

5. Conclusion

Water management of family house was assessed by system LEED used over the world and system BEAS that is developed for Slovak conditions. The results of assessment are very different. Family house achieved in field of water management 60 % from possible points in system BEAS. On the other hand this same family house achieved only 40 % from possible point in system LEED. This highlights to the need for assessment of building by system developed for the conditions of the given country. The different building environmental assessment tools do however require varying amounts of data for their assessment. The system and methods of impact rate classification are also different and mostly respect their national conditions and requirements. The system BEAS respects and adheres to Slovak standards, rules, studies and experiments.

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