JSACE 3/12

Inclusion of 'Green' Principles in the Design of Pre-School Buildings

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Received 2015/06/03

Accepted after revision 2015/08/20

http://dx.doi.org/10.5755/j01.sace.12.3.13023

Statistical data indicates that educational institutions are in the second place from the aspect of energy consumption in the commercial sector with account just over 11% of total energy used by this sector. A great part of the preschool facilities in Serbia dates back to a period of time when there were no eco-friendly thinking in the building design process and construction. Research has shown that these are the buildings of older construction, energy inefficient and often dysfunctional with disrupted the parameters of stay comfort. The significant part of built fund is actually neglected and without planed strategic steps for regular keeping and maintenance.

This study defines and valorizes concrete steps and methods for environmental, energy-efficient and economic reshaping in accordance with pre-defined standard, which will provide healthier living conditions, reduce the negative effects on the environment and climate changes and achieve significant energy savings. Applied functional - technical solutions in international pre-school buildings are analyzed in order to identify their positive characteristics and potential. Gathered knowledge and foreign practical experiences are used in the process of creating models adaptable to the areas and needs in Serbia.

The main objective of research is seen in the tendency to determine and emphasize the direction of future green architectural practice in the area of pre-schools institutions' building design. The basic idea is to initiate the new design activity which imperatively includes concept and principles of green architecture. Final results of mentioned process are a well thought out and detailed environmental - energy successful green buildings. With their environmental performances, ''green'' buildings of pre-school institutions, as a group of public purpose facilities, in addition to their positive impact on the growth and development of residing children population, directly contribute to the global energy efficiency increase and reduction of harmful impacts on the environment. The realization of the concept of ''green'' in the area of architecture requires the active cooperation of all the factors of the community.

KEYWORDS: child, ecological reshaping, green principles, model, preschool building.

Introduction

Constant growth of the world's population and increasing urbanization induce intensified pressure of natural resources and endanger the environment thus directly threatening public health, social and economic developments. Amongst all other industries, construction industry causes the largest environmental influences. Additionally, we are facing serious energy and natural resource shortage, where global climate change is the problem which cannot be ignored (Hsieh et al., 2011). At all levels of society, in all spheres of human life and work, there is evident, positive transformation in the direction of changes in energy policy, establishing of the policy for rational use of energy, inclusion of renewable energy sources in buildings, changes in social circles, etc. Consequently, over the last two decades the construction industry has made efforts to develop green building

Journal of Sustainable Architecture and Civil Engineering
Vol. 3 / No. 12 / 2015
pp. 65-74
DOI 10.5755/j01.sace.12.3.13023

practices (Gluch, 2006). Between 2008 and 2012, there was dramatic growth in the percentage of companies which are into green type of building so to achieve lower operating costs (increased to 30% from 17%) and to gain a branding / public relations advantage (increased to 30% from 22%) (LEED).This is not the case in developing and transition countries, as well as in Serbia.

Priyanka (2014) says that the ideal "green" project preserves and restores habitat that is vital for sustaining life and becomes a net producer and exporter of resources, materials, energy and water rather than being a net consumer. Also adds: "Green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources". The Office of the Federal Environmental Executive defines term "Green Building" as the practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and (2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle (Howe, 2010). In addition, the Environmental Protection Agency (EPA) describes: "Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction (Howe, 2010). This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Building Science Corporation defines that 'Green building' is a label for the process of design and construction which aims to produce buildings that are less damaging to the environment—and the people that use them—than most buildings currently built today. It focuses on incremental steps to solve known and measurable problems with ... current practice. Fischer (2010) claims that the Green building can be characterized as integrated building practice that significantly reduces the environmental footprint of a building in comparison to standard practices. Explanations of green building generally concentrate on a certain number of common segments, especially siting, energy, water, materials, waste, and health, and utility that is also threatened as an explicit design element for a kind of green buildings, known as high-performance buildings.

Because of the significance and the role that pre-school facilities have in the development of children's personalities, investing in the field of reviving and renewal of existing built fund, and also in construction of new one, is more than justified. Therefore, the future architectural practice should be imperatively directed towards providing comfortable, healthy and motivating accommodation within inner and outer environment of preschool buildings through inclusion of green architecture principles.

Nowadays, green building and architecture in Serbia is a modern trend opposite to the period until 2011 when legislation did not even mention green and building in the same sentence; the only thing that was done during that eco-unfriendly period, regarding green building principles, consisted of copying foreign examples and getting familiar with this subject from their experiences. Tanic quotes standards that were adopted: in 1967 (definition of maximum heat transfer coefficient), in 1970 (the parameter coefficient k), 1980 (summer treatment regime was introduced into the budget), 1987 (specific heat losses of buildings), 1998 (specifying the methods and manners of calculation) (Stankovic, Tanic et.al, 2014). We are witnesses of a change in thinking and therefore consequently change in legislation (building law), where a major part in building code has been dedicated to energy efficiency. Paragraphs from this section are being applied daily, regularly and this subject occupies big amount of media attention, but still, awareness of people is not on required level.

Methods

A methodology research was defined for the very purpose of determining the basic principles of green building and transformation methods of already built pre-school facilities into eco-friendly buildings and to determine, adopt and apply the most favorable model of specific measures to preschool facilities in Serbia. In order to define new standard in green building the research comprises the analysis of current literature, follows new trends in the field of green building and analyses of completed buildings with high eco properties. Also, comparison of the analyzed projects with the

emphasis on the positive and negative characteristics, energy efficiency and indoor quality parameters plays major part in defining and adoption of new standards. The aforementioned analyzes were done with the aim to form a model with specific measures that will be widely applicable to whole building fund of pre-school facilities built in Serbia. Main conclusion and final observations are presented at the end of the research work.

Review of Principles of green architecture

Results

The term "green building" has been adopted over the world to describe the concept of design, construction, finishing, equipping and using of facilities that is based on the principle of sustainability. Principles of green building comprise a systematic and overall understanding of all the environmental impacts that appear throughout the building's life cycle, and demand to improve the environmental performances throughout each phase of building life cycle. It considers maximum use of renewable and environmentally clean energy sources (solar energy, wind energy, biomass energy, hydro-energy, energy of natural and artificial water flows, water energy, geothermal energy...), conservation and recirculation of water and energy, use of natural and recyclable materials in construction, use of energy-saving materials (insulation, heating systems), use of sustainable technologies (environmentally and economically), design in harmony with nature and opening of the interior towards ambient, establishing a dialogue between buildings and architectural environment with nature (Kostic, 2012).

Environmental Protection Agency states that green buildings are emerged with the intention to reduce the overall impact of the built environment on human health and natural environment by:

- efficiently using energy, water, and other resources;
- protecting occupant health and improving employee productivity;
- reducing waste, pollution and environmental degradation.

According to Halliday (2008) and Sev (2009) the basic principles and strategies of sustainable development, in the built environment, should encompass environmental, economic and social aspects. Basic principles on which ''green'' architecture is based and which are applied to the buildings for pre-school education are viewed through:

- maximum preservation of the natural environment at the site, minimizing the impact to natural areas that may be in function of space for children stay in an outside healthy natural environment;
- energy, water and material efficiency;
- improving the indoor environment of the building of pre-school institution, establishing the conditions that will ensure adequate air temperature, amount of sunlight, air humidity and adequate air circulation, the conditions for a "healthy" building;
- preservation of the wider living environment area (using eco-friendly materials);
- environmentally conscientious maintenance and management of the buildings and its systems.

Fowler offers ideas and comprehensive guidance on how to implement the sustainable design principles-principles of green design (Fowler, 2012).

The planned construction should be completely in compliance with the principles of green architecture. These principles are systematized in following table as features that classify building in one of two types.

Based on the analysis and interpretation of listed features in Table 1, each building can be classified in one of two types of buildings. The key problem presents the existing built fund of building constructed during period when there were no norms of environmental and energy-efficient, sustainable architecture, and when people's awareness of environmental protection was not suffi-

Table 1
Comparison between "green buildings" and "non-green buildings" (Samer, 2013)

Building Type	Green building	Non-green building
Energy Consumption	low	high
Water use and treatment	Very Good	Good
Indoor Environment Quality	Very Good	Good
Emissions	Low	High
Waste Management	Highly Efficient	Efficient
Building Materials	Environmentally Friendly	Not Environmentally Friendly
Project Practices	Sophisticated	Normal
Feasibility	>5% than Threshold	Threshold

ciently developed. This building fund has been identified as non-green building type. In this case, the main priority is directed towards finding eco-effective, quick and cost-effective systems for establishing the connection between principles of environmentally friendly and energy-efficient architecture with existing, inefficient, polluting building fund. In this sense, the revitalization method proved as convenient way to mitigate adverse effects on environment and, as well, to improve the comfort of stay in indoor environment.

Serbia has the potential to build facilities in accordance with mentioned principles. In particular, great potential is recognized in the sphere of inclusion of renewable sources of energy. The Republic of Serbia can produce almost half of its energy needs from renewable sources of energy; nevertheless, the annual exhaustion is only 18-20% of its total potential (Kostic, 2011). In order to stimulate use of RSE and other features of green architecture in Serbia, government needs to advance its attitude towards this kind of energy and manners of green design and construction through following activities: simplifying the administration, raising the awareness within population, motivating investors, and forming suitable mechanisms for funding projects concerned with this important issue- RSE.

Efficient functional – technical solutions in international pre-school buildings practice

This section of research is dedicated to the analysis of foreign practice and emphasizing their positive characteristics and potential.

Nursery and Kindergarten in Zaldibar, Spain

New building Nursery and Kindergarten in Zaldibar, Spain was designed by Hiribarren-Gonzalez and Estudio Urgari (Fig. 1). The project has a total built area of 663.00m2 developed into one-storey building. The building is aimed to be used by children aged between 0-2 and 2-3. The building is based on good thermal insulation (continuity and adequate thickness) incorporated into the construction system, the maximum use of daylight as the best solution for achieving comfortable conditions of stay, use of geothermal heat pumps and solar heat system, use of ecological and recyclable material (the radiate pine wood from local forests). Structure of building, roof, partitions and facade are formed from local wooden prefabricated panels. The roof of the building is constructed with proper water proofing, which also continues in ventilated facades, and zinc cladding. It also provides proper ventilation of the floor. The design and layout of windows (windows in the façade at different heights, sizes and colours) have been studied in order to achieve and enable a high degree of natural lighting, increasing solar gains and reducing heating energy consumption. The prefabricated boxes forming the window frames are also designed according to the inclination to control solar radiation. The building facilities are designed to contribute higher degree of energy efficiency. By installation of an under floor heating system, the thermal quality and energy sav-

Fig. 1

Nursery and Kindergarten in Zaldibar, Spain, 2013. Architects- Hiribarren-Gonzalez and Estudio Urgari (available at http://architizer.com/projects/new-building-for-nursery-and-kindergarten-in-zaldibar/)

ings are improved. Energy gained from biomass is used for heating of the building premises and preparation of hot water. These technical solutions and principles of green architecture are done with aim to reduce energy consumption and CO2 emissions, and this way, support to the local economy, environmental comfort and especially quality of life of children are ensured.

Farming Kindergarten, Vietnam

Farming Kindergarten located in Biên Hòa, Dong Nai, Vietnam is designed by Vo Trong Nghia (Fig. 2). The building is constructed for low-income factory workers' children, therefore construction budget was quite limited. Architects have created a form of a long continuous track with two side operable windows to provide optimal cross ventilation and natural lighting. Following energy-saving measures are included: green roof as an insulation, green facade as shading and solar water heating. This way of providing effectiveness of the building and comfortable reside for children for a result has no need for kindergarten to install air conditioners within children's premises. Inclusion of these devices and creating them clearly visible, makes children familiarize themselves with eco-friendly thinking and get educated in terms of sustainability. Apart from all mentioned measures that are visible, more important saving method is comprehensively applied in greenery irrigation system that uses recycled wastewater. It has been concluded, by recording and monitoring the building for 10 months, that the building saves 25% of energy and 40% of fresh water compared to baseline building performance, greatly reducing its running cost. Thus, the mixture of local materials (ex. bricks, tiles) and low-tech construction methods also contributes the process of reducing environmental impact as well as promotion of local production.

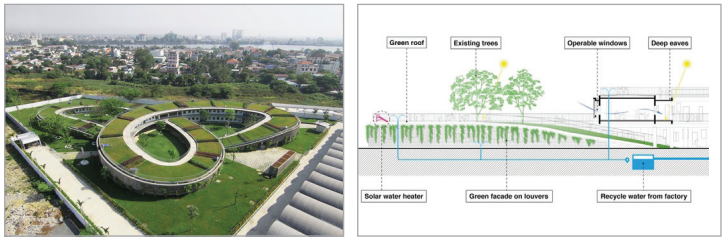


Fig. 2

Farming Kindergarten, Vietnam, 2013, Vo Trong Nghia Architects (available at http://www.archdaily.com/566580/farming-kindergarten-vo-trong-nghia-architects)

Discussion

Overview of condition of preschool facilities in south-eastern region of Serbia

Research of existing preschool facilities in the City of Nis and one part of southern Serbia was conducted from 2011 to 2013, as part of the scientific project "Revitalization of preschool facilities in Serbia: the program and methods of improving environmental, functional and energy qualities", financed by the Serbian Ministry of Education, Science and Technological Development. Analysis of condition of preschool buildings and their facilities from the aspects of type and condition of building envelope, systems of heating, cooling, ventilation, lighting, energy consumptions, the condition of indoor environmental quality includes 32 buildings located in southeastern region of Serbia. The collected data are analyzed and systematized. Table 2 illustrates four distinctive examples.

Most of pre-school institutions' buildings construction fund in Serbia is from period of the seventies and eighties when environmental aspects of architecture were not sufficiently present and visible. Actions towards recovery and revitalization of this group of public buildings started only since the year 2000. Lack of heat and sound insulation, relatively bad daily and artificial lighting,

Table 2
Characteristics of the four preschool buildings

Preschool building Location Year of construction Total built area Number of floors	Description of building envelope roof, facade, floors, joinery	HVAC systems	Annual consumption of the electric power
Kindergarten Bambi Nis, 1978-1981, 2146.20m^2, P+1	_ Flat roof-thermally insulated; _ Façade- thermally insulated _ (bricks with fugues d = 12cm _ polystyrene d = 5cm, _ reinforced concrete d = 18cm or clay block d = 12cm;) _ Floors- without thermal insulation (surface finishes parquet floor and ceramic tiles) _ Doors and windows -aluminum frames, double glazed	_ Own boiler room; _ Fuel type - coal and wood; _ Isolated pipelines; _ Without automatic heating regulation; _ Natural ventilation; _ AC system does not exist	33390.00 kWh
Kindergarten Crvenkapa Nis, 1978, 1644.80m^2, P+1	_ Pitched roof with mineral wool d = 6-8 cm _ Façade- without thermal insulation (façade brick d = 12cm) _ Floors- without thermal insulation (surface finishes parquet floor and ceramic tiles) _ Doors and windows -aluminum frames, double glazed	_ City heating plant - "Jug" _ Fuel type natural gas and fuel oil _ Isolated pipelines _ Without automatic heating regulation _ Natural ventilation _ AC system does not exist	78083.28 kWh
Kindergarten Cvrcak, Nis 1983-1984, 1683.81m^2, P+1	_ Pitched roof without thermal insulation _ Façade-ventilated façade without thermal insulation _ Floors- without thermal insulation surface finish parquet floor and ceramic tiles. _ Doors and windows-wooden frames, double glazed	_ City heating plant - "Krivi vir" _ Fuel type natural gas and fuel oil _ Isolated pipelines _ Without automatic heating regulation _ Natural ventilation _ AC system does not exist	46560.00 kWh
Kindergarten Slavuj, Nis, 1964, 1115.5 m^2 P+1	_ Pitched roof with thermal insulation d = 10 cm at midlevel construction slab _ Façade –with thermal insulation d = 4 -6cm, _ Floors without thermal insulation (surface finish - vinyl floor tiles, ceramic tiles, parquet floor m, terrazzo floor; _ Doors and windows - PVC frames, double glazed	_ City heating plant - _ "Krivi vir", _ The capacity of the installed boiler 120kW, _ Fuel type natural gas and fuel oil _ Pipelines are not isolated _ Without automatic heating regulation _ Natural ventilation AC system does not exist	59297.76 kWh

absence or existence of inefficient HVAC systems, inadequate interior materialization, can be defined as general leading issues and problems in these buildings. General characteristics of these pre-school buildings in Serbia are:

_ Designed solutions that are out of date (obsolete building fund),

_ The lower level of construction quality (in a number of pre-school facilities),

- Energy inefficient and often dysfunctional and with disrupted the parameters of stay comfort,
- Absence of maintenance measures, and
- Worn-out of building HVAC systems and their technically inefficient usage.

The analysis of building features

The analysis of the parameters that define building envelope and services, the spatial, acoustic, light, air and aesthetic comfort in these facilities is shown in the following section.

The average age of examined buildings is 31.5 years. Some common characteristics can be found in all facilities: free-standing type of facilities, placing on flat terrain, and in most cases they are two-storey buildings (ground floor aimed to be used for kindergarten and first floor for nursery).These buildings have the same or very similar type of building envelope. The finish layer of façades is mainly made of brick plaster (8.5%) and concrete (8.5%). Although the building has been built in accordance with building legislations of the time, since then, the policy regarding energy efficiency has been modified several times. Overall methods of revitalizing façade layer may differ. Therefore, additional layer of insulation could be installed on external walls, if necessary. Pitched roofs (83%) are covered with clay elements and smaller number with galvanized plasticized sheet, flat (17%) roofs are mostly —"sprinkled" with gravel. Maintaining of flat roofs on regular basis is a ground rule to avoid bigger problems and damages caused by leaking as result of failure of hydro-insulation on the flat surface of the roof. Apart from this technical suggestion, it may be acceptable to re-design existing rooftops and create green-roof construction in the form of open terrace which can be used by children and personnel. External joinery of the building is wooden (67%), aluminum (21.5%) and PVC (21.5%).

Central heating system is present in most of preschool facilities. A certain number of facilities use individual coal and wood boilers while some buildings use oil boilers and there are preschool buildings that are connected to the district heating system. Plumbing, sewage, heating system and other devices should have been replaced more than once, but in the absence of financial support for maintenance, these systems are operating in more or less original arrangement (Jevremovic, 2012). Heating systems are outdated and inefficient, uneconomical, without isolation of pipelines in unheated parts of the building and without automatic heating regulation. Heating and cooling system may be improved by using and designing passive system for heating and cooling in the building (e.g. solar panels can be easily installed on the flat and pitched roof).

In terms of ventilation, rooms in these facilities are generally naturally ventilated, unidirectional, applying temperature differences and air flow, in some cases, various appliances are used (Stankovic, 2003). Factor that partially disrupts air comfort is presence of outdated covering that emits particles and vapors. Regarding indoor environment with most buildings, original condition of materialization and equipment is dominating and some noticeable changes in the interior are present in only a few places. Refreshment of internal space is present only within the limits of painting the walls and ceiling surfaces from time to time.

Area and volume of space of group residence rooms is in the specified range. The buildings are designed for a specified capacity of children, but given the situation and lack of accommodation capacity on the state level, it is common case to exceed the design capacity, and so, in this respect, in a portion of these buildings, spatial comfort is partially damaged. Correction of this situation is perceived as providing sustainable capacity through construction of new facilities for preschool education or adaptation of existing buildings for other purposes into space reserved for institutionalized children's education. Light comfort of most of the buildings is in good condition especially in terms of achieving light effects, as they have no adverse effects on the performance of children's daily activities. The disadvantage is evident in the field of energy efficiency since high percentage of incandescent lamps is dominant. It is therefore necessary to take measures to

eliminate and replace energy inefficient lamps with contemporary energy efficient lights that will not cause any negative effects.

The revival of these facilities should significantly also be in their aesthetics. The following has been observed by analysis of the interior of these buildings: general lack of aesthetic elements of comfort, uniformity of space, lack of inspiration and imagination. Generally speaking, attractiveness of these facilities is extremely poor. Aesthetic comfort can be collected at a significantly higher level by applying modern interior design solutions in general.

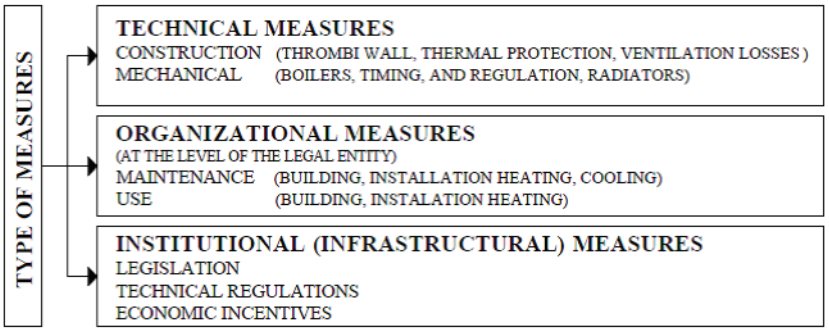
Crucial phases in the process of revitalization of the preschool buildings

Revitalization can be construed as the process composed of phases and activities, mutually connected operations that happen in established order within certain time interval. Rough and approximate display of the stage, through which revitalization, as planned process of improvement of conditions in pre-school facilities is realized and understands the following:

- Research and recording of conditions in pre-school facility in sense of testing its organization and functioning; research and recording of conditions in macro-surrounding and pre-school facility (value and significance, condition, architectural integrity and nature of the facility) – observing, measuring, sampling, noting and documenting, interviews, etc.; analysis of the surrounding in which the project of revitalization is realized;
- Analysis of researched condition, which includes analysis of obtained research results, tested indicators, measuring, , calculations, etc.;
- Estimation of facility's condition as well as estimation of the factor of environment that acts either as a risk/threat or as an advantage;
- Synthesis of findings and determining of revitalization field;
- Implementation of solutions into individual projects;
- creation and development of project revitalization;
- project realization.

Types of possible measures for increasing the efficiency of pre-school facilities are illustrated in the model (Fig. 3).

Fig. 3
Measures for increasing the efficiency of pre-school buildings



Conclusions

The research has shown that existing building fund, including pre-school facilities in Serbia, is not in correlation with features of green architecture. The significant portion of these buildings is actually untreated and without planned steps for habitual preservation and servicing. After detailed examination of existing preschool buildings in southeastern region of Serbia, a set of practical

solutions for preserving the environment, reducing energy consumption and improving the quality of the stay in pre-school institutions' buildings can be defined:

- procurement and installation of insulation and replacement of external doors and windows;
- purchase and installation of more efficient equipment and systems for controlling energy consumption, rehabilitation or replacement of the systems for hot water conduits in terms of losseselimination;
- reduce the use of electricity for heating using heating equipment with higher energy efficiency, an energy-efficient equipment for biomass burning, solar collectors, increasing the efficiency with automatic control system installation and the like;
- installation of energy efficient lighting systems;
- other works performing and purchase of equipment that promotes energy efficiency;
- replacement of worn-out, final lining of the indoor environment.

Implementation of new technologies and efficient HVAC systems, existing materials of improved quality and introduction of new environmentally friendly materials and equipment in the area of external and internal environment of preschool facilities, would not only rise comfort of children to a significantly higher development level, but it would also contribute the process of saving environment for future generation.

"One of the ways to initiate extensive revitalization of pre-school buildings in these areas, with aim of their sustainable development, is to initiate projects that would firstly define the methodological approach and general principles, and then concrete actions in the implementation buildings' reconstruction, taking into consideration possibilities to move to renewable energy resources and choice of the most rational forms for use in given circumstances (Kostic, 2011)." However, it is necessary to ensure coordination in decision-making at the level of local government in the areas of urban planning, production and consumption of energy in the building management sector, housing and public construction, protection of environment and resources (Stankovic, 2010).

Acknowledgment

This paper is realized within the first phase of scientific project of the Faculty of Civil Engineering and Architecture of the University of Nis "Revitalization of preschool facilities in Serbia: The program and methods for environmental, functional and energy efficiency improvement" financed by the Ministry of Education, Science and Technological Development Republic of Serbia.

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