



Places and Technologies 2015

KEEPING UP WITH TECHNOLOGIES TO MAKE HEALTHY PLACES

Nova Gorica, Slovenia, 18.–19.6.2015

PT2015

BOOK OF CONFERENCE PROCEEDINGS

*A healthy city is one that is continually creating and improving those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and developing to their maximum potential.
Health Promotion Glossary (1998)*

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Places and Technologies 2015

**KEEPING UP WITH
TECHNOLOGIES TO MAKE HEALTHY PLACES**

BOOK OF CONFERENCE PROCEEDINGS

Editors:

Alenka Fikfak, Eva Vaništa Lazarević,
Nataša Fikfak, Milena Vukmirović, Peter Gabrijelčič

Nova Gorica, Slovenia



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ENVIRONMENTAL FEATURES OF BUILDING MATERIALS OF TRADITIONAL OHRID HOUSE AND THEIR CONTRIBUTION TO ITS HUMAN DESIGN

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ABSTRACT

Selection of materials for the construction of a house can significantly affect the extent to which it will be characterized as a "healthy home". Having this in mind, the paper discusses the environmental impact of applied building materials in the case of a traditional Ohrid house which was selected as a representative of vernacular architecture in the Balkan region. Respecting the principle of relying on local resources which is a characteristic of vernacular architecture, materials used for the construction of Ohrid houses are natural, non-toxic, most of them are organic, and none of them causes environmental pollution during the deconstruction, i.e., does not threaten its natural course.

Consideration of the impact of building materials on the environment emphasizes the positive characteristics of selected natural materials as well as sustainable character of building principles of Ohrid masters. The following criteria were analysed: the amount of energy embodied in the particular material; the use of natural materials; locally produced building materials; use of durable materials; level of toxicity; recyclability; waste minimization; reuse of materials and the biodegradability of materials.

The aim of this paper is to point out that the principles of environmentally responsible construction applied on the case of the Ohrid vernacular architecture are timeless guidelines in construction of healthy and sustainable architecture. The established character of being ecologically friendly and healthy which is typical for applied materials on selected examples of vernacular architecture, offers the opportunity for a review of sustainable strategies that are used for several centuries, but still keep their significance in contemporary sustainable practices and environmental design.

Keywords: *traditional Ohrid house, natural materials, non-toxic materials, low-embodied-energy materials, biodegradability.*

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INTRODUCTION

Sustainable construction is defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles" (SABD, 2002). Careful selection of environmentally sustainable building materials is the easiest way for architects to start with incorporation of sustainable design principles in buildings. Having this in mind, the issue of the use of materials is increasingly being observed through their ecological aspect, i.e. their environmental profile. This term represents a method for identification and assessment of environmental impacts associated with building materials, covering various aspects of interaction between a material and the environment: embodied energy and pollution, waste generation and recycling possibilities, but also the issue of energy conservation and energy efficiency (Jong-Jin and Righton, 1998). Negative environmental impact can be mitigated through the use of sustainably harvested building materials and finishes, materials with low toxicity in manufacturing and installation, as well as through reuse or recycling of building materials (SABD, 2002).

The principles of Life Cycle Design provide important guidelines for the selection of building materials (Jong-Jin and Righton, 1998) since the environmental impact of each step of the manufacturing process is examined -from the extraction of raw materials, manufacture, distribution, and installation, till the ultimate ending in a form of reuse, recycling or disposal. Material's life cycle could be observed into three phases: Pre-Building, Building, and Post-Building (Jong-Jin and Righton, 1998) that correspond with the life cycle phases of the building itself. Evaluation of an environmental impact of a building material at each stage enables creation of a healthy built environment, based on resource efficient and ecological principles. The objective of this paper is to identify an environmental impact of building materials that were applied in the Ohrid vernacular architecture in all three phases of material's life cycle. The study was conducted through the following steps: elaboration of the basic characteristics of the traditional Ohrid house, followed by identification of applied building materials as a direct object of this research. Finally, the generally accepted sustainable qualities of building materials were presented as criteria for determination and elaboration of "green features" of analysed building.

BASIC CHARACTERISTICS OF THE TRADITIONAL OHRID HOUSE

The term Ohrid's vernacular architecture refers to the traditional secular architecture of the town of Ohrid represented by the traditional, Ohrid house. This house can be characterized as a regional variant of the Ottoman type of urban house with specific indigenous characteristics, which are specifically related to the spatial plan and structural details. The Ohrid region has a Mediterranean - continental climate, which imposed that this house is organized in two parts – a winter and a summer apartment (Чипан, 1982). Even though the buildings form a very dense



urban matrix, every house enjoys plenty of sunshine, fresh air, and a beautiful view (Fig. 1).



Figure 1: House of the Robev family and part of the house Uranija (left), Traditional Ohrid houses along the street St. Sofija (right).

The traditional Ohrid house is constructed from various traditional building materials, presented and described in Table 1. Two main building materials - stone and wood, were applied in the two constructive systems: massive stone masonry - lower part of the house representing the winter apartment, and a light wooden structure, the so-called *bondruk* system - upper parts of the house representing the summer apartment (Хаџиева Алексиевска, 1985). In that way the house responds in the best way to the climate conditions during the year (Чипан, 1982).

Table 1: Building materials of traditional Ohrid house.

Type of building material	Origin, basic characteristics of the material and its application on the Ohrid house
Stone	untreated (crushed) and/or treated stone blocks, excavated from the immediate surroundings or from the local quarry; the treated stone blocks originated often from previous buildings and monuments from the site;
Wood	beech or fir wood from the immediate surroundings;
Mud mortar	the most common binder of the stone walls;
„Čok“ plaster	traditional plaster applied to the exterior surfaces of the <i>bondruk</i> wall; made of hydrated lime, fine sand, offcuts of timber, and straw or animal fibber;
Lime based plaster	traditional plaster applied to the interior surfaces of the <i>bondruk</i> wall; made of hydrated lime or dry pulverized lime, river sand, and a small amount of a material with pozzolanic features (ground volcanic stone, powder dust from clay tiles or pozzolanic earth);
Glass	glass commonly used at the territory of the Balkans in the 19 th and at the beginning of 20 th century;
Clay tiles	made of clay from the immediate surroundings;



The massive system was constructed of stone walls, built of stone blocks and bonded with mud which was the most common binder, although there are examples where lime mortar was also applied. It represented a very durable structure. On the other hand, the *bondruk* wall which was constructed of basic timber frames consisting of post and beam structures with trusses or braces supporting at the corner points. This type of timber frames was widely applied, since it allowed the houses to be built quite quickly and the timber material did not have to be of a top quality (Radivojević et al., 2014). One of the peculiarities of the Ohrid house is the *bondruk* wall itself - 18 cm thick wall. Such wall, which is a combination of two layers of wooden-frame walls and an intermediate air layer represents a very light construction with good insulating properties.

THE SUSTAINABLE QUALITIES OF THE ANALYSED BUILDING MATERIALS

Three groups of criteria are identified in this research on the basis of material's life cycle. They are used in further analyses in order to determine and compare environmental or "green" features of the building materials used for construction of the traditional Ohrid house (Table 2) that represent sustainable qualities of a particular material that was designed, manufactured, and applied with environmental considerations (Jong-Jin and Righton, 1998). The presence of one or more of "green features" in a building material can assist in determining its relative sustainability.

Table 2: Sustainable "Green" Features of Building Materials of Ohrid Traditional House.

Material's life cycle phase	Criteria	stone	wood	clay tiles	earth (mud)	čok plaster	interior insulator	glass
Pre-building phase: Manufacture	waste reduction	+	+		+	+	+	
	pollution prevention	+	+	+	+	+	+	
	recycled content					+	+	
	embodied energy reduction	+	+	+	+	+	+	
	use of natural and/or naturally based materials	+	+	+	+	+	+	+
Building phase: Use	reduction in construction waste	+	+	+	+	+	+	
	use of local materials	+	+	+	+	+	+	
	energy efficiency	+	+					
	use of non-toxic or less-toxic materials	+	+	+	+	+	+	+
	durability	+		+				+
Post-building phase: Disposal	reusability	+	+	+				
	recyclability - hypothetically		+	+	+			+
	biodegradability		+	+	+	+	+	



The organic material basis of the house, as well as its characteristics of biodegradability, reveal a natural cycle of these buildings. The use of local, natural, non-toxic, and biodegradable materials enables a comfort in the quality of life during the whole lifecycle of the building. In many cases materials were obtained locally, even at the building site itself. Natural materials used in the example of the Ohrid house are lower in embodied energy and toxicity, in comparison with man-made materials. They required less processing and are less damaging to the environment. Their biodegradable feature enables saving energy in the process of disposing of the construction waste in the post-building phase.

Application of durable materials with low maintenance requirements represent another sustainable feature detected in the example of the Ohrid house. The ground floor of Ohrid house is built from treated and untreated blocks of stone, which is a material that is well-known for its durability. The applied treated stone was usually in form of a stone capital, part of tombstone, etc. It originated from the 6th till 9th century and in 18th or 19th century was incorporated into the massive walls of Ohrid houses (Н.У. Завод и Музеј Охрид, 2010). Unlike the stone, wood cannot be characterized as durable material. However, in the example of Ohrid traditional house beech wood from the immediate surroundings, which is hard and durable, was the most commonly used wood type. A significant ecological feature observed in the Ohrid house is the way the wood is protected and its life extended. Wood protection consisted of natural resources, such as: vinegar, oil, wax and tar (Чипан, 1982). They are non-toxic, eco-friendly products, while today, most commonly used materials for wood protection are chemical coatings that are often toxic and significantly more expensive than the natural materials.

From today's point of view, the materials implemented in the traditional Ohrid house (such as wood, clay tiles, and glass) can be easily dismantled, sorted into common groups of materials, and recycled. Some of the materials used in the construction of Ohrid house possess the so called recycled content feature of a building material. In the analysed case, the traditional plasters applied to the interior and exterior surfaces of the *bondruk* wall of Ohrid houses can be characterized as materials produced partially from construction waste.

CONCLUSIONS

It can be concluded that the identified "green features" implemented on the analysed case that are in correlation with the contemporary defined sustainable "green" features of building materials. Saving energy and resources were the primary goals of the master-builder of the traditional Ohrid house. The economy and rationality, as important virtues of the master builder, contributed in a large extent to finding smart solutions with regards to on-site waste minimization. Even in the pre-building stage, i.e. in the very process of design and the organic perception of architecture, the basic, conceptual foundations of the modern sustainable architectural design could be traced. The use of standard dimensions



and the modular coordination in the design process (Хаџиева Алексиевска, 1985) allowed reusability of the elements of construction and finalization. Implementation of this sustainable strategy, the so-called design for reuse (Jong-Jin and Righton, 1998) reveals the relevance of the concept of this vernacular architecture for the modern, sustainable practice. This kind of building cycle represents a perfect form of circulation of the material that is in a good shape, so the use of new raw materials and resources is kept to a necessary minimum.

The use of non-toxic materials for the construction of buildings is vital to the health of construction workers and the user house. Local, natural and non-toxic materials (stone, wood, earth, sand, pozzolana, gravel, animal hair, straw, brick and glass) representing the material base of Ohrid houses are responsible for a healthy indoor environment ecological house. Applied organic materials are biodegradable, so during the deconstruction they do not pollute the environment.

From the results of presented analyses one can assume that the sustainable architecture is not derived just from the application of the latest technological advances to reduce negative impact of buildings on the environment, but it is also achieved by a simple application of local materials and building techniques, good site planning, smart management of the building materials and environmentally conscious design. It is believed to be the solution for creating healthy, ecological and timeless architecture. This is also a strong argument for the significance of the protection and conservation, not only of this particular type of traditional house, but of vernacular heritage in general.

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