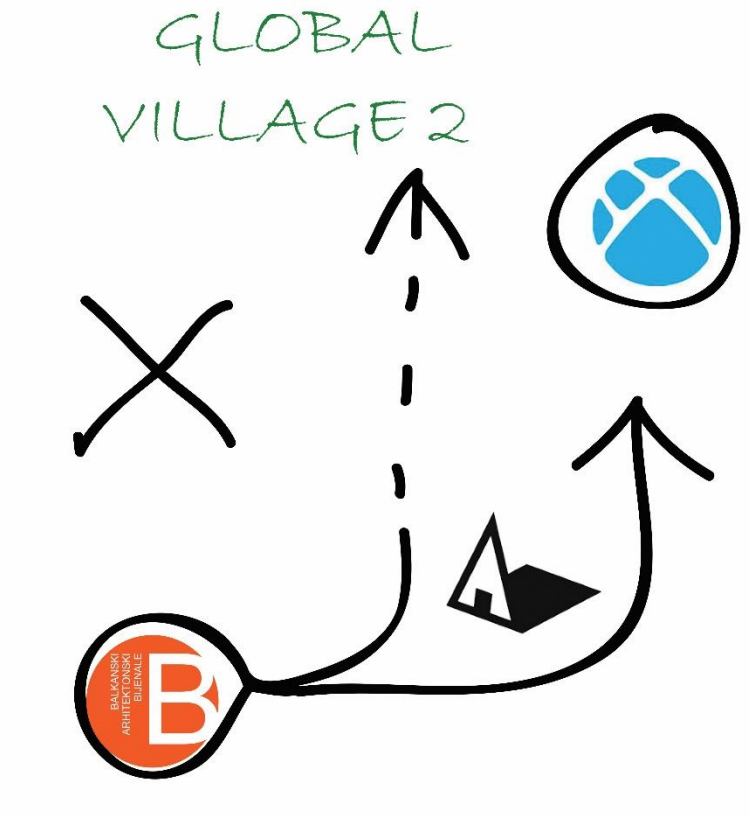

Conference proceedings

GLOBAL VILLAGE - SHELTER FOR RESILIENT LIVING 2

On-line version

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PREFACE: GLOBAL VILLAGE – UTOPIA OR REALITY?

res. ass .dr Tatjana Mrdjenovic, Faculty of Architecture in Belgrade
Conference conceptor and Editor in chief

The discussion will start debates about the diverse paradigms of suburban, rural, and urban places in today's global society, and it will do so by comparing these three types of locations. The primary point of contention is whether a Global Village should be categorized as an idealistic utopia or a feasible possibility for the foreseeable future. This debate will explore the advantages and disadvantages of each type of location, considering factors such as population density, infrastructure, and access to resources. Additionally, it will delve into the social, economic, and environmental implications of striving towards a Global Village concept. In the conversation that will bridge hierarchical and network viewpoints, we will investigate the idea of needs. Let's investigate some alternative ways of living to the one we are now accustomed to, on the presumption that we ought to consider the requirements that have been produced. These alternative ways of living may include sustainable communities, eco-villages, and self-sufficient neighborhoods. By considering the requirements that have been produced, we can explore how these alternative living arrangements can address issues such as energy consumption, mobility, built environment, waste management, and food production more efficiently and environmentally friendly. Furthermore, examining the social and economic implications of these alternative ways of living can shed light on the potential benefits and challenges they may bring to individuals and society as a whole. The core beliefs and identities held by people all over the world help to foster the growth of a diversified socio-economic and cultural network that spans a variety of geographic regions. This network serves as the basis for a worldwide community that is referred to as the Global Village. Within the context of our increasingly interdependent global community, this idea stands as a singular example of new communalism. As a result, Global Village would like to draw your attention to the following topics, most of which are also being explored in the thematic sessions of the conference:

1. ARCHITECTURE OF GLOBAL VILLAGE: PATTERNS, FORMS, SYSTEMS
2. PLANNING AND ARRANGING THE GLOBAL VILLAGE: INSTRUMENTS AND MODELS
3. MODERN TECHNOLOGIES IN RISK MANAGEMENT OF TERRITORIES
4. FORMS OF MOVEMENT AND MOBILITY MANAGEMENT IN THE GLOBAL VILLAGE
5. THE ROLE OF URBAN PLANNERS IN MANAGING THE CLIMATE TRANSITION
6. NEW MODELS OF ARCHITECTURE IN TRANSITION
7. RESILIENT CITIES IN THE ERA OF GLOBALIZATION: URBAN INTERVENTIONS TOWARDS A SUSTAINABLE FUTURE
8. HEALTHY city HEALTHY people: designing future cities for "mind body and soul"
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RESIDENTIAL BUILDINGS ENERGY PERFORMANCE OPTIMISATION - FAÇADE OPENINGS AND SHADING DEVICES

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ABSTRACT

This paper presents a methodological approach to optimization of facade openings and shading devices on residential buildings in the city of Belgrade, Serbia, from the aspect of building's energy performance. The research is carried out using digital simulation tools, simulating a selected type of residential building, varying the conditions of the urban environment in which the building is located, the size and geometry of facade openings, as well as the types of sun shading elements, taking into account the functional, financial and social aspect of their application on residential buildings in Belgrade. The dimensions and types of openings and shading devices are evaluated based on the simulation results, taking into account differences in individual apartment's energy needs based on orientation and the position in the building. The analysis of the obtained data and their mutual synthesis leads to recommendations for the design of residential buildings of the observed type for the climate conditions of Belgrade.

Key words: energy performance, windows, façade, shading, residential buildings

1. INTRODUCTION

In the context of global warming, as well as the increasingly pronounced urban heat island effect, overheating of buildings during the summer months is becoming an increasing problem. The transparent parts of the facade envelope are the zones of the most intense heat exchange between the interior and exterior spaces. In order to improve the performance of the building and reduce the need for energy consumption, it is necessary to adequately design window openings and sun shading elements, taking into account all the functional and aesthetic aspects of the building as well as the limitations imposed by the visual comfort conditions and technological / structural aspects of the building.

This paper focuses on how the building openings – their size, shape, division, and material characteristics along with shading devices – their type and usage pattern influence energy performance of a typical residential building. This paper presents a research methodology conducted in formulating a PhD thesis on this topic.

2. METHODOLOGY

Research methodology is adapted from research papers with similar topic of research.[2] Research is carried out into three main segments: Model formulation, Energy simulation and Result Analysis which are subdivided into smaller segments that describe and analyze more closely all the relevant aspects of the main topic.

Firstly, in order to determine the influence of façade openings and shading devices on energy performance, there has to be a base building model on whose energy performance these influences are measured / simulated. Model building is chosen based on its quantity in Belgrade's building stock and its relevance for the research topic. Chosen building model is placed in the urban environment that corresponds to this building type's real-life surroundings in order to simulate the influence from built and natural environment.

On the determined building model, the changes are made on the size and geometry of window openings in the digital simulation software, varying their sizes both uniform on the entire façade and relative to their position in the building on the vertical axis – examining the influence of window-to-wall ratio and urban environment on the building's solar gain. These variants are simulated in all four cardinal directions. Secondly, shading devices are added to the model. Types of shading devices considered for research are valorized in the respect of their influence on building's energy performance and frequency of their use on residential buildings in Serbia. Chosen shading device types are then applied in the energy model and simulated with different usage patterns, taking into account differences in user behavior affecting energy performance.

After analyzing the results of both façade openings and shading devices in all the simulated variants, optimal combinations of size and position of windows and types of shading devices are given for all the cardinal directions, discussing the different possible combinations and resulting outcomes on building's functional, aesthetic and energy performance aspect.

3. MODEL FORMULATION

Literature review suggests that most of research conducted on the topic of optimizing facade openings and shading elements from the aspect of energy performance is conducted on office buildings (52%), while residential buildings are the subject of only 14% of research in the aforementioned topic, [5] even though they are the space in which we spend most of our time and are therefore, the focus of this research. Since the research can mostly influence the building of new buildings, they are a starting point for consideration. Based on the National Typology of Residential Buildings in Serbia Constructed since 2013 [3] most often built type of residential building after 2013. is the four-storie freestanding building, so that type has been chosen as a base model.

The model is materialized in accordance to the Rulebook for energy efficiency [6] for newly-built buildings. Digital model building is placed in four variants of urban environment with differences in proximity of surrounding buildings, their heights as well as the proximity and existence of tall vegetation.

4. BUILDING ENERGY SIMULATION

When it comes to digital simulation software for running the calculations there are many different options to choose from. For this research, Design Builder is the software that was chosen because of its availability, ease of use, and being equipped with all calculation modules required for this research.

First aspect that is simulated is the influence of size and geometry of window openings on energy performance of a building. In first simulated scenario window sizes and shapes correspond to the chosen building type from the Typology. Then, that same window area would be arranged differently on the façade, measuring the impact that window geometry and number of divisions have on energy performance. Minimum window area taken into account is a minimum prescribed by the rulebook for the visual comfort, while the maximum window area analyzed is maximum possible having in mind constraints imposed by the building's structure. Windows are also varied in size from bottom to top of the building, reasoning that apartments on lower floors need bigger openings due to them being in shade from neighboring buildings and trees. Higher floors, while not requiring as much sunlight, have better view and are usually more expensive to buy, thus also earning them the consideration of larger window openings.

Second aspect is the influence of shading elements on building's energy performance. All variants of shading system are simulated on a single type window. Shading devices considered in this research are the

ones used most commonly in residential buildings in Serbia. [4] Only outside shades will be taken into account since their influence on energy demand is greater [1] as is their impact on the visual identity of the building. Therefore, the shading devices chosen are the roller shades and outside horizontal louvres – fixed and movable, which are the most widely researched shading devices according to Kirimtat et al. [5].

5. CONCLUSIONS

Designing a building with adequate window-to-wall ratio and shading elements can largely improve its energy performance. In order to do so, many case-specific aspects need to be considered including building's function, orientation, occupancy, urban environment and user behavior.

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