Facsimile Reconstruction of Villa Bozic with the Application of Energy Efficiency Measures

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ABSTRACT

The paper examines the reasons for carrying out the facsimile reconstruction of Villa Božić in Banja Luka, with the application of energy efficiency measures. The villa was built in 1912 by the prominent Croatian architect Rudolf Lubynski. It was heavily damaged by an earthquake in 1969 and completely demolished in 2002.

The proposal to reconstruct the entire villa in its original form takes into account its historical value, the possibility to change its use and use modern materials to reduce its energy consumption. The methods proposed concern the installation of thermal insulation, LED lighting and geothermal heat pumps. Relevant computer software was used to simulate the results of the proposed energy consumption scheme. The results obtained taking into account the proposed energy efficiency measures are compared with those obtained without their application.

KEYWORDS

Banja Luka, villa, Secession, facsimile reconstruction, thermal insulation, geothermal energy, geothermal heat pump

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INTRODUCTION

Architectural design is one of the most important disciplines practiced by human civilization. By tracing the development of architecture it is possible to trace the development of human civilization through time, with individual structures representing indelible marks documenting the time in history in which they originated, sometimes more convincingly than any written evidence. Each and every house is the expression or actualization of an idea storing permanently information about the culture, wealth and mentality of the people who constructed it and used it. The disappearance of a house is a loss for its society, whereas the renewal or reconstruction of any culturally and historically important building is an act of preservation of a major link in the chain of a community's cultural and historical development.

This article discusses the possibility and rationale behind the idea to carry out a facsimile reconstruction of Villa Božić in Banja Luka, as well as the possibility to employ measures of energy efficiency in the process of reconstruction of the teardown.

In accordance with the 1989 preliminary design for the reconstruction of Villa Božić, this paper examines the possibility to introduce measures of energy efficiency, in terms of use of thermal insulation materials, the installation of a heating system using geothermal heat pumps, and the installation of LED lighting for the purpose of curbing power consumption. The findings and the application of these measures in the reconstruction of a culturally and historically significant building will be presented and commented on herein.

VILLA BOŽIĆ – DESCRIPTION

In terms of style, Villa Božić is representative of Secession. This style originated in Vienna in 1897, when two architects, Josef Hoffmann and Josef Maria Olbrich, and the painter Koloman Moser joined in revolt against the Vienna Academy of Arts and, guided by Gustav Klimt and with Wagner's blessing, started the Vienna Secession. Based on a blueprint by Klimt, the Secession Building was erected the next year. It took a very short time for the new style to spread across the Austrian-Hungarian Monarchy, as well as the adjacent countries, which were under Vienna's immediate cultural influence. Secession was first mentioned in Bosnia and Herzegovina in the final years of the 19th century, but the first house in this style was constructed in 1902.

Several houses were built in Banja Luka typifying the Secession style, but very few of them have been preserved to this day. Villa Božić was one of them. It was a major architectural accomplishment from the period of Austrian-Hungarian rule in Banja Luka. The house was nicknamed the 'Red House' because of the colour of its facade. It was designed by the renowned Zagreb architect Rudolf Lubynski.

The villa was located in the very city centre, in Srpska ulica.[3] Previously, this street constituted a special urban and architectural complex, which was irreversibly impaired in

[3] During Austrian-Hungarian rule, the street was called Salvatorgasse, and until 1992, its name was Fra Grge Martića.

the wake of the above-mentioned earthquake, when many buildings were torn down and the preserved ones underwent inadequate interventions.

Figure 1. A historical photograph, Villa Božić between the World Wars
(Source: *Banjaluka koji ima i koje nema u 1000 slika*)

Information about the architect

Rudolf Lubynski (1873-1935). A Zagreb architect considered one of Croatia's greatest Secession architects, with a couple of noteworthy building designs representative of modernism. He studied at the Technische Hochschule in Karlsruhe [1], after which he worked for Josef Durm. [2] One of his best known designs is the National and University Library located at Marulić Square, Zagreb.[3] This building, considered a master piece of Secession architecture in Croatia, is the seat of the State Archives of Croatia today. Even though he made a couple of functionalist designs, Lubynski produced his best designs in the Secession style. He was the architect of the Great Sephardic Temple in Sarajevo.

Figure 2: A photograph of Villa Božić in the 1980's, showing traces of time and neglect that gradually led to its demolition
(Source: *Banjaluka koji ima i koje nema u 1000 slika*)

Background

The construction of Villa Božić lasted until 1913.[4] It was built by Ivan Božić, a timber merchant. For a while the house was occupied by the Božić family, and was subsequently sold to Mara Mitrov. Over the next period the house was used by the Mitrov family of revolutionaries, one of whose prominent members was the national hero Danko Mitrov.

After the proclamation of the Vrbas Banate, Svetislav Tisa Milosavljević, its first Ban, used the villa as his place of residence in the period between his arrival in Banja Luka (1929) and the completion of the Banski Dvor Palace (1932). [4] The Kolo Srpskih Sestara Charity had its seat at the villa in the ensuing period.

During World War II, the villa was the seat of the Kulturbund.[5] In the aftermath of the war, it housed several institutions, such as the Midwifery School, the Red Cross and the Welfare Centre. [5] The house was damaged in the 1969 earthquake. Based on first-hand evidence and photographs taken at that time, it may be concluded the house did not suffer any major damage. Some of the roof was damaged, which led to the house losing that part of the roof structure. Brought into that kind of condition, Villa Božić soon became derelict, which is evident in the photographs taken in the years that followed. Not even the efforts of Sabira Husedžinović, who deserves the credit for making Villa Božić a listed building in 1989, managed to start renovation. The house suffered from exposure to dampness and became increasingly rundown; it was finally demolished in 2002. The partly preserved fence is the only remaining element of the building complex which once included the house and an accessory building. Following a review of the 'Centre-East' regulatory plan, the site of the former Villa Božić is intended for the construction of a residential and office block.

[4] The house was entered in the Cadastral Register in 1913, so it may rightly be supposed it was constructed prior to that date (information provided by Sabira Husedžinović).

[5] An association for the preservation of German culture, founded by the ethnic Germans in the Kingdom of the Serbs, Croats and Slovenes (Schwäbisch-Deutscher Kulturbund)

Figure 3: The site of Villa Božić today
(Taken by Siniša Cvijić)

The design of the villa

Villa Božić was a detached, symmetrical building lying on a rectangular foundation. The house was entered on the north side, off Srpska ulica. The entrance was positioned centrally, and it was sheltered with a semicircular glazed windshield. A staircase led into the hall. The villa had a ground floor and a mansard storey, which extended above the entire ground floor area.

The ground floor contained rooms, a kitchen and a pantry. The utility section was accessed from the yard. A grand wooden staircase linked the hall with the mansard storey, which had four rooms, arranged symmetrically in relation to the hall, a bathroom and a toilet. There was a small staircase leading to the attic from one of the rooms.

The ground floor rooms, which were situated along the street, had polygonal bays limited to the ground floor. There was once a wooden terrace extending from the western wall of the ground floor, which was removed after World War II.

The facade facing the street represented the most prominent part of the villa. There was a polygonal pediment above the entrance, with four elongated windows separated by elliptical ornaments. All the windows in the house were modulary coordinated with the windows on the front facade.

The form of the house is a well-proportioned polyhedron; it has a mansard roof, with symmetrically arranged openings.[6] The design reflected the preference for geometry characteristic of Secession architecture, announcing new modern solutions which ensued. The Vienna Secession developed these design elements in the first decade of the 20th century. They revealed the beauty of pure and simple forms.[6] In the conceptual sense, this architecture aspires to functionality.

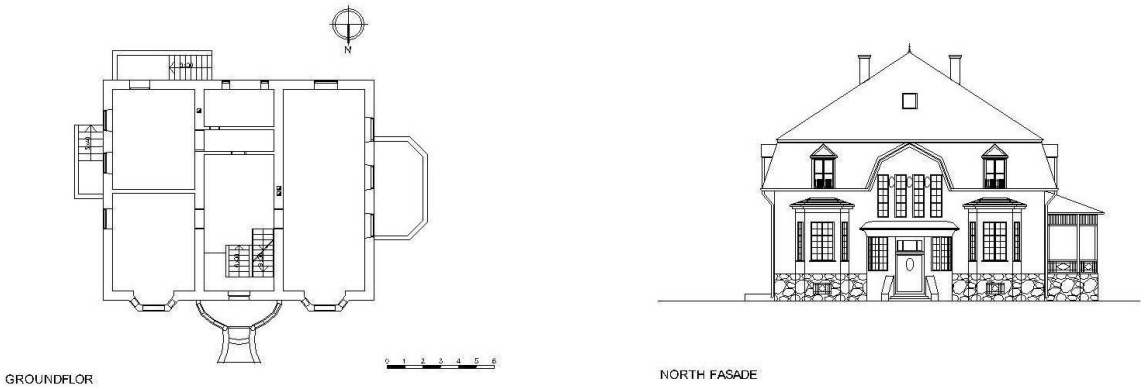

Figure 4: Ground floor plan and the street façade of the house
(Sketch by Tijana Glamočić)

THE METHOD OF FACSIMILE RECONSTRUCTION IN THE REGENERATION OF BUILDING HERITAGE

Reconstruction is a process involving the building of a valuable object, structure or complex, damaged to a significant degree, in ruinous form or completely demolished, to restore it to its original form, including both its interior and exterior. Some theoreticians call this facsimile reconstruction, which accentuates the main properties of this kind of regeneration, which is the exact reproduction of the structure concerned in its original, i.e. previous condition. Reconstruction must be based on accurate documents and valid information, never on assumptions. The collection of reliable data to be used in reconstruction requires a lot of research. [7]

It is interesting to quote dissenting opinions concerning reconstruction, especially facsimile reconstruction. The Venice Charter adopted in 1964 explicitly rejects it, whereas current conservation practices approve of it, provided certain strict conditions are met:

[6] Preservation Proposal, Villa Božić at Martićeva no. 34. The text was written by Sabira Husedžinović.

- When an original building or complex is demolished unexpectedly and abruptly (in a war, by adverse weather or due to other reasons) and there is a strong need to rebuild it in its original or previous form;

- When a reconstruction project, irrespective of the time and manner of demolition of the original building or complex, is very important in terms of culture, education, etc. [8]

Most certainly, it should be borne in mind that any project of facsimile reconstruction must count on the original blueprints or very good, detailed photographs of the structure concerned, taken immediately prior to its demolition. Whether or not there is collective memory of the demolished structure at the time when the reconstruction project is lauched is another very important factor.

The Stoa of Attalos II in Athens, the Old Bridge in Mostar, Žitomislić Monastery, Stare Miasto in Warsaw are some examples of projects of facsimile reconstruction completed to date. Also worthy of mention is the project of reconstruction of the City Palace in Potsdam, Germany, due for completion in 2011. This edifice was heavily damaged in a bombing raid in World War II, and its remains were cleared from the site in the 1950's. The proponents of reconstruction of this culturally significant building believe that once rebuilt, it will revive the old spirit of Potsdam downtown.

In considering the possibility of facsimile reconstruction of Villa Božić, it must be clearly ascertained which of the above-stated preconditions are met.

Villa Božić is distinctly representative of the Secession style in Banja Luka. It was built to the design by the renowned architect Rudolfa Lubynski, typical of the kind of architectural style generally accepted and created in developed regions and communities. It was one of very few such designs in Banja Luke.

In terms of historical relevance, Villa Božić was the venue of several significant events that marked Banja Luka's past, and its reconstruction will bring back a building bearing testimony to the city's history.

The time elapsed since the last remains of Villa Božić were removed is fairly short, so it may be assumed the building still exists in the city's collective memory and its reconstruction will contribute to the preservation of the city's unique genius loci.

The existence of detailed photographs will ensure the reconstruction of an exact replica of the house.

The critical stance of some theoreticians towards the reconstruction of teardowns may be the only argument against the facsimile reconstruction of Villa Božić.

The reconstruction of the house does not necessarily imply the reallocation of the original use. Given its cultural and historical significance, the house should become a gallery or exhibition space. As Banja Luka does not have a city museum, Villa Božić

may be allocated for this use. That would allow the connection of its original use with a new one, whose purpose would be to collect and exhibit items representative of city life in Banja Luka.

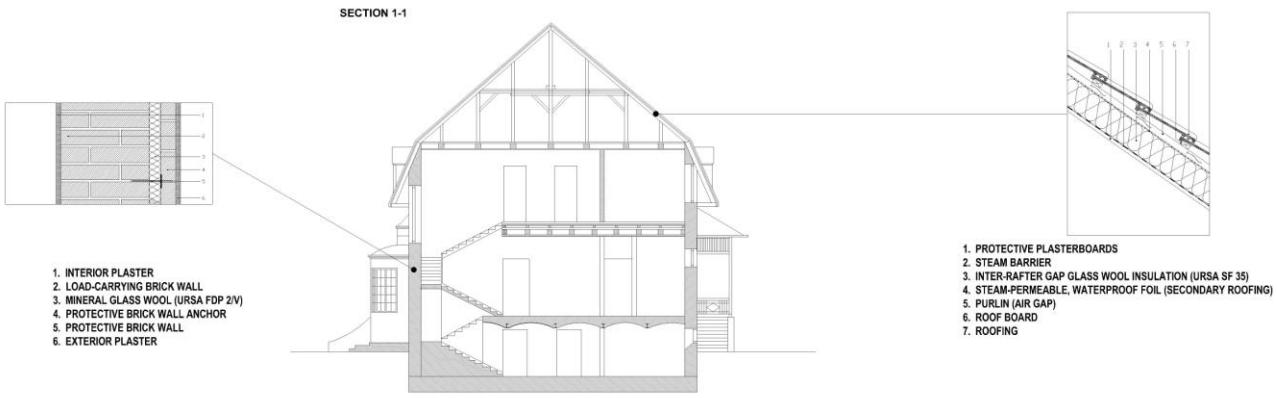

Figure 5: Villa Božić, a cross section showing layers of the walls that can be used to make the reconstructed house more energy efficient
(Drawing by Tijana Glamočić and Siniša Cvijić)

IMPLEMENTING ENERGY EFFICIENCY STANDARDS IN THE FACSIMILE RECONSTRUCTION OF VILLA BOŽIĆ

Architectural and construction measures for improving energy efficiency

Originally, Villa Božić was made of bricks, and the basement walls were masonary. The walls were plastered on both sides. A brick floor separated the basement from the ground level. The floor separating the ground level and the mansard storey was made of wooden joists. The mansard roof was an uninsulated timber structure.

The exact replication of the visible parts of the structure is an absolute reconstruction requirement. Contemporary materials may be used for the invisible parts of the structure to maximize the energy performance of the house. To that end, it is proposed that the walls consist of several layers, with bricks plastered on both sides. A layer of thermal insulation should be placed inside the wall to reduce its thermal conductivity. The reconstruction project should also include the thermal insulation of the roof.

The window openings were fitted with traditional double casement windows in box frameworks. In terms of window type and shape, double casement windows are proposed, with double-glazed exterior window panes.

Calculations have been made to compare the heat loss of the original house with that of the reconstructed house with improved energy efficiency. The findings are presented below.

The heat loss of the original house was calculated in accordance with the 'Regulations for Calculating the Energy Requirements for Buildings' from 1983, which were based on the German DIN 4701 standard, and the heat transfer coefficients for the exterior surfaces were calculated based on JUS U.J5.600. The heat loss due to ventilation was calculated based on DIN 4701 from 1959, which was incorporated in the new JUS M. E6.010 [9]. The impact of wind on the house was estimated for the wind speed of 4 m/s for normal areas and sheltered buildings.

The heat loss of the original house, according to the design of the house as described in the above-mentioned blueprints, equaled 48,940 W, or approximately 111.2 W/m^2 of the heated area. The annual energy consumption used for heating was estimated at approx. 123.5 kWh/m^2, and it was calculated using the following formula [10]:

$$q_{god} = q\ SD \text{ kW h/m}^2 \quad (1)$$

where q_{god} is the annual heat loss of the house in kWh/m^2, q is the heat loss for the heated space per day and degree difference between the inside and outside temperatures, kWh/day^{o}Cm^2, and SD is the number of degree days, equaling to 2774 for the City of Banja Luka, on the assumption the heating was suspended daily for eight hours.

According to the new preliminary design, the envelope, ceilings and floors will be insulated, and windows with improved energy performance will be installed. This will help reduce the heat loss, which will amount to approx. 19,880 W, or around 45.2 W/m^2 of the heated area, on the condition the house is continuously heated.

The calculation results show that by using multi-layer insulated walls and changing the mode of operation of the central heating system the heat loss of the building may be reduced by about 29,000 W. In addition, the capacity of the heat source to be exploited for its heating can be almost 60% lower than what will be needed if the proposed measures are not implemented.

Use of geothermal energy and LED lighting for the imporvement of energy performance of Villa Božić

The existing documents do not state explicitly how the old building was heated. Taking into account the rates of heat loss as calculated based on the new house design, using a low-temperature heat source for the house is proposed.

Figure 6. Borehole heat exchangers [13]

Given the position of the house, which is located in the very city centre, as well as the impossibility to change its exterior, a geothermal heat pump is proposed as the heat source, which would provide all the energy needed to heat the house in the heating periods. The ground would be used to feed the thermal heat pump, and because there is little space availabile, the heat exchangers would not be laid horizontally, and borehole heat exchangers would be used instead. The collected heat would be carried to a thermal pump, which would be placed in the basement of the building (Figure 6).

Bearing in mind the need to preserve the original interior of the house and the maximum water temperature that may be obtained using geothermal heat pumps, the house would be heated using a system of pipes fitted in the floor (underfloor heating, Figure 7). The estimated annual consumption of energy to be used for heating the house would equal approx. 70 kWh/m^2, on the assumption the system operates continuously during the heating season. Assuming the average annual COP of the heat pump is 4 [12], the consumption of electric power per m^2 of heated space would be 17.5 kWh/m^2 in the heating season.

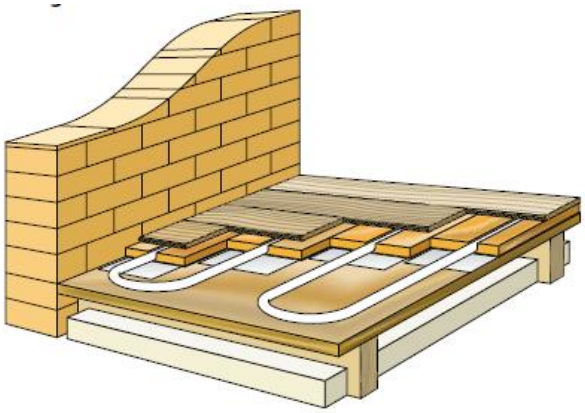

Figure 7. Joisted floor with hardwood or laminate floor coverings [11]

If the energy efficiency measures as proposed by the new preliminary design are implemented, they will help reduce the heat loss of the house from 111.2 W/m^2 to approx. 45.2 W/m^2. At the same time, this would lower the annual consumption of power used for heating to 53.5 kWh/m^2 of the heated area, i.e. to 23,540 kWh for the whole house.

Typically, there are two types of rooms in museums and galleries: exhibition rooms and administration offices and storerooms. Exhibition rooms require the installation of tungsten halogen lamps in order to provide lighting as similar to natural as practical.

Accordingly, the assessment of the potential installation of LED lighting can take into account the offices only.

Let us consider the replacement of 58w T8 fluorescent light bulbs with the luminous flux of 3750 lm, with 21w T8 LED lamps, with a guaranteed luminous flux of 2080 lm. A T8 fluorescent light bulb emits light in all directions, covering 360°, whereas T8 LED emittance is directional, covering an angle of 120°. A set of 3 T8 fluorescent bulbs with the luminous flux of 7875 lm and the total power of 174 w will be replaced with a set of 4 T8 LED bulbs with the luminous flux of 7488lm and the total power of 84w.

Evidently, the proposed solution will produce 5% less light, which is a negligible reduction with no bearing on the human eye; also, LED lamps have a lesser tendency to weaken during operation / service life. Also, electric power consumption will be reduced by 90w, while ensuring practically the same luminous efficacy. This will amount to an annual reduction of 720-765 kwh per lighting unit, at estimated 8000-8500 hours of operation per year. The total reduction will be approx. 45%.

CONCLUSION

Considering the fact that Villa Božić represents one of Banja Luka's most significant buildings representative of the Secession style and the existence of photographs taken prior to its demolition, we are in favour of the idea that it should be reconstructed using the facsimile method.

Submitting a petition to the Commission to Preserve National Monuments of Bosnia and Herzegovina to inscribe Villa Božić in the national heritage list was the first step intended to ensure the preservation of the site of the villa. The procedure of listing the villa in the Temporary National Heritage List of Bosnia and Herzegovina is under way. Until the final decision has been made, the site will remain under temporary protection.

Led by the idea that building heritage should be preserved, and by recommendations for rational energy consumption, it may be concluded that facsimile reconstruction will allow the implementation of up-to-date measures intended to reduce energy consumption. It is equally important to note that facsimile reconstruction may be combined with opting for different, renewable energy sources, as demonstrated by the case study presented in this paper.

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