Neolepenism – the new thermal comfort construction facilities

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Space design can be one of the strategies for designing low-energy and passive houses and buildings. Neolepenism is a new, internationally copyrighted type of energy efficient architecture with roots in the prehistoric culture of Lepenski Vir (Serbia). The author has previously presented the model of a small family house of neolepenism with a flat roof at 50th Congress and Exhibition of KGH in Belgrade in 2019 and wrote about the energy efficiency of the prehistoric architecture of Lepenski Vir, whose positive experiences he improved and optimized. This new industrial design could significantly contribute to the reduction of heat losses (in winter) or gains (during the summer season), reducing greenhouse gas emissions and saving building materials and thermal insulation, primarily by its compact shape, and to a lesser extent by utilization favorable orientation, by digging in earth, application of green roofs and aerodynamic shape. In this way, neolepenism could have a positive impact on global warming and climate change as a passive means of protection.

Keywords: neolepenism, Lepenski Vir, Green technologies, space design, compactness, surface heating/cooling

Introduction

Due to energy efficiency and energy savings, engineers must be involved in the work of designing living space, although architects are primarily in charge of that. Designing energy efficient forms can be one of the strategies for designing buildings with low energy consumption.

Recommendations for achieving passive house standards usually state what such a house should contain in terms of materials and equipment, but not what that house should look like: in [1] it is only considered that "a passive house should have a compact shape with good thermal insulation." Therefore, architects and engineers must come up with an optimal solution and design through integrated design.

"In general, buildings consume about 40% of the world's energy. Using the holistic approach of house design, up to 50% of such energy can be saved [2]".

The most compact shape is the ball. But, the ball is not usable for living. When it comes to orthogonal geometric bodies, the cube is the most compact. The compactness of form of neolepenism architecture is somewhere between the ball and the cube. In this way, neolepenism could have a positive impact on global warming and climate change as a passive means of protection. If we use holisic approach of house design, a lot of energy produced in buildings can be saved, including savings in construction materials and thermal insulation as well as energy for production of these materials.

Basic information about the archaeological site Lepenski Vir

Lepenski Vir was discovered in the 1960s. The site is well known by its sculptures, architecture and graves. Lepenski Vir is settled on the right, Serbian side of the Danube River in Djerdap Gorge, 15 km upstream from Donji Milanovac and about 160 km downstream from Belgrade.

The person deserving the most merit for its discovery was Dragoslav Srejović, archeologist, whose book *Lepenski Vir – a new prehistoric culture in the Danube region,* published in 1969 by SKZ, is the main source of information on this culture. The site is estimated to be about 8,000 years old. Due to construction of HEP Djerdap 1, the original site was sunken, and the site was displaced due to sinking. The level of the Danube grew by about 12 m, while the current site was moved by some 150 m up to the hill, but the original position was maintained. Nowadays, Lepenski Vir is a museum. The museum preserves the site from devastation due to climatic effects.

Only bases of the houses, made from a hardened material resembling concrete, are preserved; hearths were incorporated in the bases at the entrance, as an active heating system. The third dimension was constructed from perishable materials (like wood, leather, mud…) and is not preserved. We can only assume what those houses looked like.

What is neolepenism?

Neolepenism is a new type of energy efficient architecture that can respond to the challenges of sustainable development. The name neolepenism is very appropriate because the prefix *neo* signifies something new, while Lepenism refers to the architecture of prehistoric settlement and culture Lepenski Vir. This architecture of Lepenski Vir controls energy flows, and within it takes into account the optimal orientation of houses in terms of meeting the needs for heating and cooling of these dwellings, as well as the aspect of urbanism of the settlement, about which the author wrote earlier (REHVA Journal, Vol. 5, 2016). The author has improved and optimized these positive experiences of Lepenski Vir architecture. He made a model of a small family neolepenismhouse of 62 square meters with a flat roof: ground and first floor, which he presented at the 50th International Congress and Exhibition of KGH (HVAC) in Belgrade in 2019 (**Figure 1**) and (**Figure 2**).

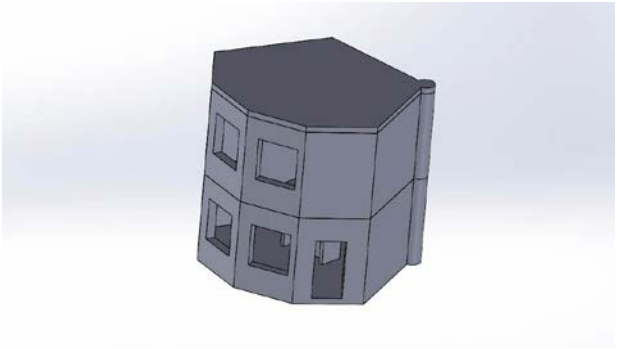

Figure 1. Exterior of a model of a small house of neolepenism of 62 m^2 with a flat roof.

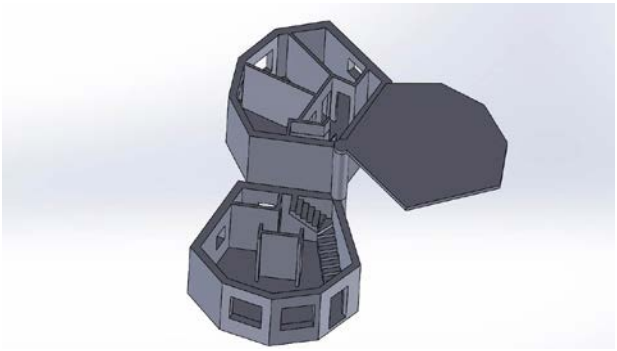

Figure 2. A look inside the model of neolepenism architecture.

We can consider neolepenism as a new Green technology with roots in prehistory. In the process of integrated model design, the author had help of four experienced architects as professional consultants in the field of interior design, one of whom is a PhD and a scientific advisor. The statics of the construction facility was not deeply considered yet and civil engineers also need to be involved. The term neolepenism for this type of architecture was suggested by Serbian actor Predrag Kolarević, when he saw the animations of the model.

The geometric shape and height of an object have influence, to an extent, on energy consumption of heating the object. Designing energy efficient forms can be one of the strategies for designing low energy and passive houses. Compactness of form is very important.

The shape of the construction facility with a flat roof of this architecture was registered as an industrial design in the Intellectual Property Office of the Republic of Serbia, through which international copyright protection was obtained from WIPO – World Intellectual Property Organization in 2020 (**Figure 3**).

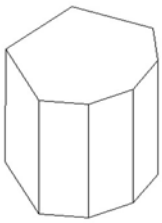

Figure 3. Author's internationally copyrighted form of construction facility with flat roof from WIPO [6].

The architecture of neolepenism has a defined basis (**Figure 4**), height, orientation and variants. It is a distinctly mathematical architecture. It is based on the adaptation of the object to the natural environment, which includes geographical, meteorological, astronomical and plant environment and takes into account the influence of solar radiation.

The predominantly eastern orientation of the building for flat terrains is recommended, as it presents a compromise between the optimal orientation for the needs of heating and cooling the interior of the building. Solar energy is directly used for heating in the morning, when the greatest needs for that energy are due to lower morning outdoor temperatures and when the incident

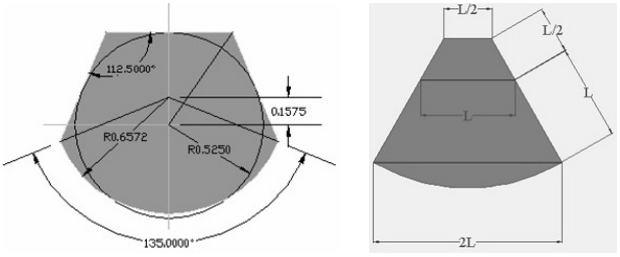

Figure 4. Calculated and optimized Basements of the objects of the neolepenism by author (left) and layout of houses on Lepenski Vir by archeologist D. Srejović [9] (right).

angles of solar radiation on vertical surfaces are most favorable. The meteorological databases Meteonorm of typical meteorological years (TMY) and the Microsoft Excel program were used in the calculations. The calculations were made on an hourly basis for the whole year and are presented by radar diagrams in the literature [4]. Calculations were done for Belgrade (Serbia), Athens (Greece) and Stockholm (Sweden) and similar results was obtained. The radar-diagrams for Athens on (**Figure 5**) and (**Figure 6**) are presented just as examples. From those figures we may conclude why the eastern orientation was chosen like optimal solution as a compromise between winter and summer needs.

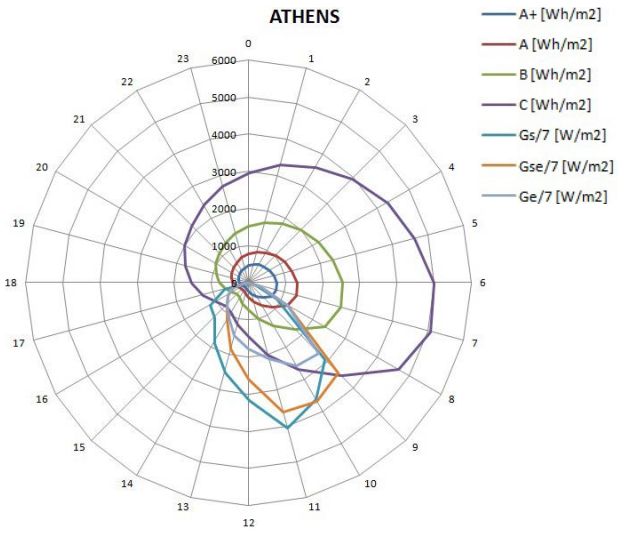

Figure 5. Radar-diagram with data from Meteonorm data bases for heat losses for different energy classes of facilities and Solar gains to different orientations for Athens [4].

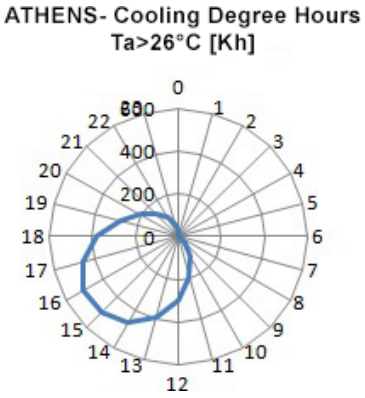

Figure 6. Radar-diagram with data from Meteonorm data bases for Cooling Degree Hours for Athens.

The recommended Heating and Cooling system

For smaller construction facilities of neolepenism, radiator heating is not acceptable, because radiator heaters and pipes take up valuable living space. However, the author assumes that, primarily due to the non-orthogonal architecture, it might be best to use surface water heating/cooling systems placed in the building envelope. The wall heating/cooling water systems are the most attractive because it is possible use the same pipelines for all year around. Also, the vertical walls have rectangular forms.

Wall heating/cooling also allows the natural ventilation, which is important, because it prevents the spread of droplet infections from the ventilation and air conditioning systems (Legionnaires' disease, corona viruses ...). During the corona virus pandemic, the World Organizations and the Associations for Air Conditioning, Heating, Refrigeration and Ventilation (ASHRAE and REHVA) published instructions and conducted online seminars on handling and operation, primarily of ventilation and air conditioning systems in order to reduce the risk of covid-19 infection [6, 7]. Water heating systems were not in the center of attention in these documents.

Surface heating/cooling systems are low temperature: "in [5] it is stated that the water temperature during heating is a maximum of 45°C, and during cooling a minimum of 13°C. (...) They are ideal for combination with heat pumps as a source of energy. (...) Floor surfaces should be used primarily for heating, and ceiling surfaces primarily for cooling. Wall systems are used equally for heating and cooling."

For bigger construction facilities of neolepenism, low-temperature modes are also attractive for use in district heating/cooling, and even in district heating without cooling: absorption cooling machines or heat pumps that use solar energy for cooling can have solar panels on flat roofs of larger neolepenism buildings for their cooling application in the summer season, and during the winter part of the heat energy could be settled from district heating or the excess heat energy could be distributed through the hot water network to consumers who lack that energy. Optimization of these systems depends on specific locations and climatic conditions, and automatic regulation plays an important role. But, the statics of objects must be considered.

Usage of flat roof

In low-energy buildings, as well as in the architecture of neolepenism, "the needs for heating/cooling are significantly reduced, but the needs for thermal energy for the preparation of domestic hot water (DHW) have remained at the same level, so that the needs for DHW become dominant [8]". The surface of the flat roof in neolepenism buildings can be used for the installation of solar thermal panels, both for heating purposes and for the preparation of DHW. During summer season solar thermal panels can be use for DHW or for cooling by heat pump.

The variant of the shape of the building of the architecture of neolepenism with a flat roof also enables the construction of a green roof (plant roof covering). This can be applied in order to reduce the heat load in summer. Also, for larger facilities, a green roof and the installation of solar panels, both photovoltaic and thermal, can be combined. It depends primarily on the wishes of investors.

It is necessary to take into account the orientation of solar panels. Their optimal orientation does not coincide with the optimal orientation of the building structure of neolepenism architecture, which is predominantly eastern. Solar panels in the Northern Hemisphere should be faced to the south.

Conclusion

The author believes that the architecture of neolepenism, with its calculated and defined form, can be a passive means of protection that can affect global warming and climate change, since buildings are the largest consumers of energy and are largely responsible for greenhouse gas emissions. Space design can be one of the strategies for designing low-energy and passive buildings and that is the simplest strategy. The current practice assumes an object of arbitrary shape, where the problems of energy efficiency were solved by the increased use of thermal insulation and an active heating/cooling system.

The paper briefly describes the architecture of neolepenism with the original pictures of a model of a small family house of 62 m². The shape of the building with flat roof of the architecture of neolepenism is internationally copyrighted by the World Intellectual Property Organization (WIPO) through the Intellectual Property Office of the Republic of Serbia as a type of industrial design in 2020.

In considering heating/cooling installations for neolepenism architecture, the author proposes the application of low-temperature surface systems, primarily wall heating/cooling, which would be installed mostly in the exterior walls of construction facilities. The author also believes that in some cases, such bigger buildings of neolepenismcan use district heating as one of the types of active heating system.

The architecture of neolepenism represents a new Green technology with roots in the prehistoric culture of Lepenski Vir. Architects and engineers need to work together in integrated design to come up with practical solutions. Urban planning, architecture and district heating can represent a harmonious energy chain of energy production and consumption in the future. ■

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