BIOMIMETIC PRINCIPLES IN ARCHITECTURE

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The application of biomimetic principles in architecture allows drawing inspiration from nature for the development of adaptive facades capable of responding to changes in external conditions, reducing energy consumption. However, the problem of integrating such innovative technologies into the building remains, in particular the question of their universality for different climatic conditions. Further research is needed to develop effective biomimetics-based design methods to improve residents comfort.

An analysis of successful international projects, such as the Institute du Monde Arabe in Paris, The Al Bahar Towers in Abu Dhabi, Kolding Campus in Denmark and The Edge in Amsterdam, which demonstrate a significant reduction in energy consumption through the use of adaptive facades, the development of which can be considered based on principles of biomimetics. These studies show how modern technologies allow architects to create buildings that are able to adapt to their environment, thereby improving their energy efficiency. The natural mechanisms of heat and light regulation, which are characteristic of various organisms, can become the basis for the development of facades capable of automatically adapting to environmental changes. The use of such systems, which include kinetic elements of facades, allows to significantly reducing energy consumption, which is proven by the examples of international projects considered in the work. The development of biomimetics in architecture provides new opportunities for the integration of natural adaptive solutions that effectively regulate heat flows and reduce the load on air conditioning and heating systems. The use of organic forms and materials promotes harmony between architectural objects and the natural environment, which not only increases comfort for users, but also significantly reduces the energy consumption of buildings.

The design of adaptive facades using biomimetics is inspired by the forms of living organisms, their behavior and the existing ecosystem of biological objects [1]. Copying the natural forms of the organism found in nature inspires architects to create new forms of architectural space. Studying how nature optimizes energy, manages water, regulates temperature, or achieves structural stability allows us to apply these principles to building design. This is how inspiration from plant processes makes it possible to design water runoff management and reduce water consumption. Facades that provide

natural ventilation regulate the reduction of the building's internal temperature.

The example of the root system of plants provides an opportunity to design water flow management and reduce water consumption. Facades that provide natural ventilation regulate the decrease in the internal temperature of the building. When designing buildings that integrate with the surrounding ecosystems, biomimetics gives the greatest result of energy saving. Imitating the natural phenomena of self-shading, biomimetic adaptive facades can optimize the efficiency of the building and increase the comfort level of the residents.

On the basis of the conducted analysis, it is shown that thanks to the introduction of adaptive facades, there is a decrease in energy consumption in buildings due to the use of the latest materials and technologies that allow facades to respond to changes in external conditions.

A conceptual solution for the application of facade systems imitating biological processes is proposed. In our opinion, a building facade imitating bivalve mussel shells can be an effective solution for increasing energy efficiency and aesthetic appeal of buildings, especially in coastal regions such as Odesa. The design of the facade involves the use of panels that automatically open on warm days to provide natural ventilation and close in cold periods, contributing to the preservation of heat in the premises. One of the key elements of the technology is the opening-closing mechanism of the panels, which imitates the movement of the flaps of mussels. This mechanism allows the facade to adapt to changes in climatic conditions, minimizing the use of artificial air conditioning or heating systems. In addition, the surface of the panels can be covered with a self-cleaning material that protects against pollution and atmospheric influences. This technology is based on biomimetic principles, particularly the ability of mussels to maintain the purity of their shells in the natural environment. The integration of such systems into building structures not only improves the microclimate in the premises, but also contributes to the reduction of energy consumption, which makes this approach to facade design promising from the point of view of environmental and economic efficiency. Modern technologies such as 3D printing and artificial intelligence allow architects to incorporate biomimetic principles into their designs more accurately and efficiently.

References:

1. Preeti Panjwani, Khushboo Sahu. Biomimetic Adaptive Facades. International Research Journal of Engineering and Technology. 2023. T. 10, № 6. C. 470-476.– Режим доступу: https://www.irjet.net