Bioclimatics in Architecture and Planning Solutions for Medium-Rise Residential Buildings

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ABSTRACT

This article analyzes the factors influencing the formation of architectural solutions for bioclimatic residential buildings. Based on this analysis, the basic principles of the formation of bioclimatic housing were determined. And also, based on scientific research, a variant of architectural and planning solutions and innovative technologies in the design of modern housing in these conditions are proposed.

Keywords: bioclimatic interactions, energy efficiency, spatial structure, adaptation, energy supply, renewable energy sources.

1 Introduction

In our temperate climate zone, where, according to statistics, there are no abnormal and unpredictable sudden climatic changes and weather events, at first glance, it would seem that nothing can affect the adoption of non-standard decisions in the planning of the interior space and the need to use unique design solutions. However, analyzing the natural influence of factors in terms of effective adaptability of the spatial environment of the building and its energy efficiency, one can find many more problems, including global environmental ones, the solution of which can be a new, to some extent innovative, approach to the design of a residential building.

The main task of designing a bioclimatic residential building is to create the most comfortable indoor microclimate and create convenience for a person that meets all the specified criteria, especially during a hot period and uses, the latest, most efficient consumption of natural resources [1-4].

After all, the main inexhaustible resource is the human intellect. It should be primarily used in design. The maximum result will be achieved with a comprehensive analysis of all environmental conditions and environmental factors. Knowledge and experience in design, its competent analysis and application, as well as proper modelling and the use of modern technologies will achieve the best result. A model that makes maximum use of intellectual resources should become a solution to new problems of bioclimatic design.

2. Factors influencing the formation of architectural solutions for bioclimatic residential buildings

2.1. Landscape and climatic factors

Landscape and climatic factors have a great influence on the microclimate of a residential building and the formation of an optimal spatial solution. The characteristic features of traditional residential buildings in different countries (Roman house, Japanese house, northern hut) are given and, as a result of considering their evolution, the main features of the organization and factors influencing the formation of such houses are identified [5-7].

Consider the influence of natural factors on the design - the influence of the natural conditions

of the building site on the formation of the architecture of the building (the nature of the relief, the orientation of the building, the nature of the coating near the building) - M. Wells buildings with green roofs, buried in the relief;

– the influence of solar radiation on the architecture of a bioclimatic building (orientation of the building, natural lighting, location of communication nodes, green spaces) – Edward Matsriy's projects based on interaction with solar energy, he formulates the dependence of the illumination of a room on the colour of the interior; Tadao Ando uses natural lighting and chiaroscuro as an element of shaping;

– the influence of air flows on the architecture of a bioclimatic building (orientation of the building, natural ventilation of the premises, atrium as a means of ventilation, aerodynamics of the building) – Ken Young considers natural ventilation and technical means for changing air flows in his projects, introduces the concept of sky courts – deep loggias on the facade for cooling;

- the influence of water spaces on the architecture of a bioclimatic building (rainwater collection, water spaces, pools, fountains) - traditional Indian dwellings in Cuba and Central Asia, located on the water, Oscar Niemeyer uses water spaces around buildings to cool and humidify air flows;

– the influence of green spaces on the architecture of a bioclimatic building (location near the building, natural filter) — green courtyards of Roman houses, gardens on the roofs of Le Corbusier's buildings, plants on the facades in Ken Young's buildings reduced the impact of solar radiation on structures.

2.2. Social and economic factors

Analysis of the influence of social and economic factors on the design of bioclimatic buildings allowed me to establish that the most important social aspect is the formation of socially responsible consciousness among consumers. The bioclimatic building, as the highest level of ecological buildings, implies the active participation of the user in the processes of saving natural resources and caring for the environment. The introduction of natural components into the building has a good effect on the physical and mental health of people, and this significantly improves and heals the microclimate, contributing to the creation of psychological comfort, especially in multi-storey and high-rise buildings.

2.3. Environmental factors

The study of the interaction of bioclimatic buildings with nature is carried out by monitoring the life cycle of buildings from design to disposal. The control is carried out by the "green buildings" certification service together with the designers. If we take care of the environment, we will achieve the conservation of natural resources, restore disturbed areas, solve closed natural problems and restore lost green spaces at the construction site, we will use environmentally friendly materials.

2.4. Energy Factors

In bioclimatic buildings, as a variety of ecological buildings, it would be advisable to use alternative energy sources, and these are:

- solar energy (solar cells, solar collectors);
- wind energy (wind generators, wind walls, wind turbines);
- geothermal energy (heat of stones, soil);
- hydrothermal energy (groundwater heat);
- biomass energy (primary, secondary);
- the energy of the flow of rivers, sea waves and others [1-4].

3. Principles of formation of bioclimatic residential buildings

3.1. The principle of adaptation.

This principle is formed by the volumetric-spatial structure of a bioclimatic building, depending on the natural resources of the area. The choice of optimal energy sources, taking into account regional characteristics (climate, landscape, energy supply, and others), response to external influences by the shape of the plan and the plasticity of the facade, the dependence of the volume of the building on the relief and wind rose.

3.2. The principle of conservation and replenishment of stocks.

In the construction of a bioclimatic building, it is very important not to reduce the total area of green spaces. The lost territory of the green

ecosystem should be replenished with green spaces in the building. These spaces are located in landscaped atriums, balconies and loggias, and exploited roofs. At the same time, the area of green spaces in the building should be larger than the area of greenery lost during construction.

3.3. The principle of relationships.

Construction according to this principle is considered that the building should be connected with the urban environment (social, engineering and transport infrastructure) and be formed in close connection with the surrounding buildings. The building being erected has an impact on the environment, as there are changes in the speed and direction of air flows and shading of other buildings and the site. The entrance group and the level of the 1st floor should be closely connected with the city, smoothly crossing the street or courtyard into the building. The building must be part of the environment in which it is located [8-10].

3.4. The principle of ecology.

The construction of the building, it's operation and waste disposal should not
harm the environment. When providing a building with energy,
use natural energy sources. When constructing a building, recyclable materials should be used. When choosing a material, it is better to choose local materials. Structural details of the building must allow easy disposal and sorting of waste at the end of the building's life so that it can be reused.

3.5. The principle of energy independence.

The principle includes the minimum use of existing external energy systems, where the energy carrier is hydrocarbon fuel; it is proposed to use as much as possible autonomous or local systems with alternative energy sources and technical devices for generating heat and electricity for a building or a group of buildings. The choice of the power supply system for such buildings depends on local environmental conditions and the availability of central power and gas supply systems.

3.6. organic principle.

The house is like a living organism, it functions according to the same rhythms and laws as the surrounding nature. The house accumulates energy in the warm season and uses it in the winter. Solar power plants, like evergreen trees, feed on solar energy and transform it. In bio-treatment plants and toilets, a natural waste recycling process is implemented, as a result of which a closed cycle is restored: the resulting grey water is filtered and used for technical needs and irrigation, and the hummus is used as fertilizer. The microclimate implies the natural process of breathing when air enters the building and is removed as a result of ventilation. Air quality is improved by plants that absorb CO2, humidify it and release oxygen [2].

Conclusion

As a result of the proposed design concept for a typical mid-rise residential building, it should be based on the principles of the formation of bioclimatic space-planning structures, as well as include innovative systems and technologies for efficient autonomous energy supply. Having studied these principles of bioclimatic architecture, it is possible to give a conceptual solution for residential development in similar climatic conditions.

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