Building materials and technologies of modern housing: architectural and environmental aspects

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Abstract. The issues of architectural and environmental solutions in the design and construction of low-rise residential buildings, including the distinctive properties of building materials, due to the conditions of modern material culture, aesthetic features of the external and internal appearance of these buildings are considered. It is noted that the conceptual approach to the choice of the technologies in the implementation of the construction of these objects helps to determine the necessary organization and structural work, as well as additional artistic means of architectural expressiveness. It is also indicated that, along with architectural expressiveness, environmental safety becomes one of the main requirements for the comfort of living in a dwelling house. Considerable attention is paid to modern building materials and innovative technologies that form new creative challenges facing architects.

Introduction
Currently, the hallmark of a high-level comfort for living in a residential building is a competent and high-quality solution of the issues of architecture and ecology in the design, construction and operation. Professionally selected architectural style of facades and interiors reflects the individuality and uniqueness of the specified object. Equally important is the level of the full-fledged engineering support and analysis of factors affecting the comfort and environmental safety of the living environment, both inside the apartment building and its surrounding space. The use of building materials in the construction of this house directly depends on the degree of compliance of the material properties with the climatic conditions and requirements imposed on them, as well as the accuracy of compliance with the technological process of this materials’ production, the quality of product design and other factors. At the present stage of increased urbanization, the relevance of the design and construction study in the field of low-rise housing construction allows us to link together the architectural and environmental component.

Purpose, objectives, research methods

The purpose of the study is to provide scientifically based proposals for improving the dwelling, in the context of architectural and environmental aspects.
In accordance with the goal, the objectives of the study are defined, which are to:
- identify trends in the design and construction of modern homes to create a high-level comfort living in it;
- theoretically formulate the concept of harmony integration in the external and internal appearance of the dwelling, ecological architecture, innovative technologies and building materials.

  The object of study is the architecture of a modern low-rise dwelling.

  The subject of the research is the principles and methods of dwelling formation, based on the unity of expediency and beauty.

  Research methods are the space-planning analysis; integrated multidimensional approach to the study of the design and construction of modern housing. The functional method that allows to reveal the role of building materials in creating a comfortable home is of importance.

  The theoretical basis of the research is the scientific work of Russian and foreign scientists on the study of modern housing, innovative materials and technologies, the problems of “green” and ecological architecture.

The main criteria when choosing a building material to create a comfortable housing

The comfort of the environment in a dwelling is created both by architectural and planning means, as well as by the use of the high-quality building materials [1]. The specific nature of the living environment is described as a special subject-spatial unity, a holistic object of the study and integrated design. Awareness of the environment as a special phenomenon is an indispensable condition for the effective development of any of its component parts [2].

The correct choice of building material for the low-rise residential buildings is a particularly important task not only in the implementation of this object construction, but also in its further operation. At the same time, it is necessary to take into account the technical criteria and parameters of the material, a complex of mechanical and special properties, artistic and decorative qualities, durability and manufacturability, as well as a number of other factors. The possibility of using various construction technologies and “green” standards necessary to create a comfortable and safe living environment in accordance with the increased environmental requirements also depends on the informed choice of the material, its functional purpose, operating conditions and technological indicators.

The geotechnical and natural-climatic conditions of the construction site play a significant role in low-rise housing construction. So, for example, “in the Krasnodar region the negative air temperatures are short, snow cover is insignificant in winter, summer is characterized by high temperature and intensity of solar radiation — all this determines the need to protect the living environment during the cold season period” [3, 4,]. Therefore, a balanced approach is needed in choosing building materials that would take into account not only this circumstance, but also make it possible to analyze the options for the influence of engineering-geological and natural-climatic conditions on the shaping in the architecture of a dwelling, among which is the function of the structure, its design scheme, architectural and compositional techniques, construction materials [5].

At the same time, special attention should be paid to the choice of materials for the construction of farm buildings, individual garages, sheds, small architectural forms and various improvement elements. At the same time, “the design, constructive solution of an individual element of improvement should correspond to the quality standards, constructive and aesthetic characteristics” [6].

The material and quality of construction are closely interrelated, the functional purpose of buildings and structures, the artistic intention of the author determine the main architectural and construction requirements for the construction and finishing materials and products used in the project and for construction. These requirements affect the choice, mainly, of natural materials with stable qualitative characteristics based on the areas and methods of their use in certain structures [7].

To create a healthy ecological comfortable microclimate of a dwelling, natural materials of natural origin and mixed natural-artificial origin are widely used, in particular, wood and stone materials obtained as a result of relatively simple processing while preserving their physical-mechanical and technological properties.
For example, the use of granite in the construction of low-rise houses makes it possible to significantly change the appearance of the house, adding additional sophistication and representativeness to it. At the same time, granite, which is a highly ergonomic material, is able to contribute its specific style to the interior of the dwelling, ensuring a comfortable stay in it. It is natural that in history everything is repeated within time. At present, materials of natural origin are in increasing demand in construction, one of which is adobe, which will remain one of the most sought-after in the future. The most valuable advantage is that in the adobe house a person feels more comfortable than in a brick one. In winter, such houses are warm, and in summer - cool, they always have dry and healthy fresh air, which has a beneficial effect on human well-being [8].

The world of natural materials of natural origin used in the construction of low-rise housing with architectural value is multifaceted. However, with all the diversity of these materials it is worth paying attention to the environmental component. The use of secondary resources is one of the aspects of economic and environmental activities, consisting in reuse of any production waste, which allows not only to increase its economic efficiency, but also to reduce the level of environmental pollution and its impact on social processes. A careful attitude to building and finishing materials, in terms of their toxicity, makes these houses healthier for their inhabitants [9].

The most important property of building materials is their different ability to extinguish external radiation and absorb radioactive pollutants from the environment. The material (building) protects a person from harmful external radiation [10].

Based on the above-mentioned it is possible to conclude that both natural materials and artificial materials manufactured according to new technologies are used for the construction of low-rise residential buildings at the present time. Before to opt for a particular material, one should build a number of criteria important for comfortable living, namely, the definable material should be:
- suitable for specific climatic conditions of the construction;
- have the appropriate properties and parameters for the construction of energy-efficient housing;
- have effective acoustic properties that prevent the effects of external noise;
- durable, ensuring proper reliability and durability of the home;
- artistic and aesthetic, playing an important role in the architectural appearance of the home.

Innovative technologies used in the construction and operation of modern housing

During the construction and subsequent operation of a modern dwelling, it is necessary to take into account the fact that “architecture is formed inside. A shell of a particular structure and form, an architectural structure, a house is created ultimately so that an internal space organized for life processes can exist” [11]. At the same time, the organization of this space should be based on the following tasks - the creation of a safe, comfortable and ecological living environment. The successful solution of these tasks is carried out by applying innovative technologies, both at the construction stage and at the stage of dwelling maintenance. Along with this, “the architects are faced with constructive tasks, the solution of which should be in close cooperation with the general planning concept” [12] of the architectural object - buildings, structures, interiors, small architectural forms.

The use of innovative technologies and materials in architecture and construction is a strategic direction of the state policy. At the same time, it is necessary to improve the quality of design and construction, the fundamental indicators of which are functional suitability, performance, sustainability, environmental friendliness, reliability and safety of a construction object [13].

The transition to “green” construction, i.e., to a minimum environmental impact in order to improve energy efficiency, the lowest consumption of energy resources of an individual dwelling, is the primary generally recognized area of innovation in low-rise housing construction. Equally important is given to secondary raw materials that have a certain value in the manufacture of new products. This is primarily necessary to stabilize the environmentally friendly level of impact on the anthropogenic and natural environment.
Fossil resources extracted from the subsoil are replaced by alternative energy sources, an adaptive solar system is used, which produces environmentally friendly electricity, while reducing carbon dioxide emissions. In the modern world there are a large number of solar devices with various characteristics and operational features.

Active and passive solar systems are used for the use of solar energy. This solution is consistent with the doctrine and the main promising principles of design and construction of highly mobile, transforming, dynamically developing and adapting individual living environment for humans [14].

Today's difficult environmental situation requires that the materials from which the building is built can be reused, and unconventional energy, using renewable energy sources, is integrated into the architecture of the building and the microclimate system [15].

However, the use of innovative technologies in the construction and operation of modern low-rise housing helps to embody the idea of individuality of modern housing. For example, the possibility of transformation, allowing for redevelopment when changing family composition, while maintaining comfort, economy and presentable appearance. The most effective innovative solutions in the construction of low-rise residential buildings is the maximum use of prefabricated structures with minimal mass, reducing the number of capital walls, the cost of their construction and operation of the dwelling as a whole, and most importantly have a great impact on reducing the time during construction of the object.

The use of composite materials which structure consists of a reinforcing substance and a matrix is also in demand. These materials have a minimum weight compared with traditional materials and high performance, and their use in low-rise housing makes it possible to create spectacular artistic and decorative elements - arches, domes, etc.

At the same time, under the influence of scientific and technological progress, there are significant changes in the technology of the construction of modern housing. There are new technologies, modern discoveries, which significantly facilitate the process of housing construction and improve the comfort of living in it.

Summary

Thus, in the design and subsequent construction of the low-rise residential buildings, architectural and environmental aspects are particularly important. Accounting for these aspects in the relationship to each other, namely in interrelated models and principles, determines the comfort of the living environment in low-rise housing. It seems quite natural and is considered to be the right choice of building materials and technologies. This greatly simplifies actions to ensure high comfort of living and contributes to its environmental safety. Consequently, a logically coordinated plan of an action and a set of architectural and environmental solutions based on innovations make it possible to achieve high results. At the same time, the system analysis, principles, methods and research tools aimed at fulfilling the set goal, namely, achieving efficiency in the design and construction carried out in low-rise housing construction, give the right to analyze in detail the advantages of ecological architecture.

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