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Architectural and Ecological Problems in the Formation of Mid-Rise Residential Buildings under the Climatic Conditions of Uzbekistan

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Abstract: This article analyzes the main architectural and ecological problems encountered in the formation of mid-rise residential buildings under the climatic conditions of Uzbekistan. The study highlights the significant impact of the country's sharply continental climate, including extremely hot summers, cold winters, strong winds, and dust factors, on the functional and energy efficiency of modern residential buildings. During the research, national architectural traditions, the experience of historical neighborhoods, and modern urbanization processes were comparatively studied. In addition, issues related to energy efficiency, natural ventilation, ecological sustainability, and the use of local building materials were comprehensively examined. As a result of the study, conceptual solutions were developed for shaping modern mid-rise residential buildings adapted to the climate of Uzbekistan while preserving national traditions. The article has theoretical and practical significance for scientific research in the fields of architecture, urban planning, and ecological design.

Keywords: Mid-Rise Residential Buildings, Climatic Architecture, Ecological Sustainability, Energy Efficiency, National Traditions, Modern Architecture, Urbanization, Natural Ventilation, Green Architecture, Neighborhood (Mahalla), Bioclimatic Design, Facade, Microclimate

1. Introduction

Today, the rapid growth of urbanization worldwide is significantly increasing the demand for residential architecture.[1] Especially in developing countries, including Uzbekistan, population growth and urban expansion have made the design of modern residential buildings one of the most important tasks. In recent years, a large number of mid-rise residential complexes have been constructed in major cities such as Tashkent, Samarkand, and Bukhara[2]. However, this process has also led to various ecological, climatic, and urban planning problems.

The territory of Uzbekistan belongs to a sharply continental climatic zone. During summer, air temperatures often exceed +40°C, while in winter the temperature drops sharply, significantly affecting building structures and planning systems. Therefore, it is essential to conduct a deep analysis of climatic factors when designing residential buildings. Since many modern residential buildings are based on foreign architectural models, they often fail to correspond to local climatic conditions and traditional lifestyles[3]. Architectural solutions formed in historical neighborhoods — including inner courtyards, narrow shaded streets, balconies (ayvons), and natural ventilation systems — evolved as climate-responsive elements adapted to local environmental conditions. (Figure 1). Reapplying these traditional approaches in modern architecture is considered an

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important factor in creating energy-efficient and ecologically sustainable residential environments [4], [5].

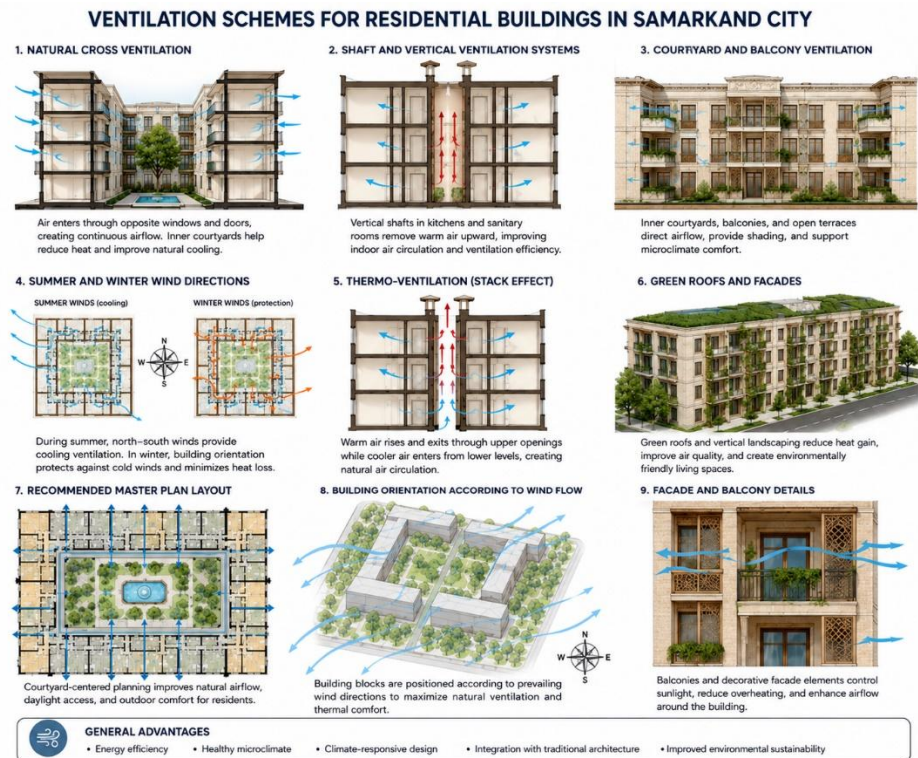


Figure 1. Ventilation and microclimate solutions in residential buildings of Samarkand
Source: Prepared by the author

In addition, ecological problems, air pollution, limited energy resources, and the reduction of green areas are creating new requirements for modern residential architecture. From this perspective, the article broadly examines the main problems in the formation of mid-rise residential buildings under the climatic conditions of Uzbekistan, as well as their scientific and practical solutions[6].

Today, however, these traditional approaches are not sufficiently applied in modern residential buildings. As a result, the national architectural identity is gradually disappearing. At the same time, ecological problems, the reduction of green spaces, and the increasing number of vehicles are negatively affecting the urban environment. The issue of ecological sustainability is also of particular importance in the formation of mid-rise residential buildings. The excessive use of concrete and metal structures in modern construction increases heat accumulation and environmental impact.[7] Local building materials, including fired brick, wood, and natural decorative materials, are considered climatically appropriate and environmentally efficient. An example of this can be seen in the analysis of a reconstruction proposal project for a mid-rise residential building based on traditional architectural elements [8], [9]. The project integrates national ornaments, decorative ceramic tiles, wood carving, and modern lighting systems. The proposed design applies architectural principles adapted to the local climate and historical environment (Figure 2).



Figure 2. Residential buildings integrating traditional and modern architectural elements
Source: Prepared by the author

In addition, the application of green architecture principles remains one of the main directions of contemporary design. Solar panels, green roofs, vertical landscaping, and energy-efficient technologies are becoming essential components of modern residential architecture. Under the conditions of Uzbekistan, integrating these technologies with national architectural traditions can significantly improve ecological and economic efficiency. (Figure 3).

2. Materials and Methods

Expansion of Green Zones

Green zones in modern urban architecture serve not only aesthetic purposes but also perform numerous ecological, social, and health-related functions, making them strategic environmental spaces. Against the background of rapid urbanization and the reduction of natural territories, the expansion of green areas is becoming a priority direction in ecological architecture. Through innovative solutions such as parks, gardens, green roofs, landscape design in inner courtyards, and vertical gardens, it is possible to restore natural ecosystems within artificial urban environments.

Green zones absorb carbon dioxide from the atmosphere, reduce noise pollution, regulate air humidity, and help prevent the urban heat island effect. Furthermore, green spaces are highly important for human health and psychological well-being. Research shows that people living near green environments experience lower stress levels and higher social activity. Therefore, one of the main objectives of ecological architecture is to restore the living connection between humans and nature.

The expansion of green zones also plays a significant role in preventing flooding through the natural infiltration of rainwater, supporting local biodiversity, and improving the urban microclimate. For example, in Singapore, every new building is planned from the design stage with integrated green spaces or green roofs. This approach contributes to strengthening the city's status as a "green metropolis."

3. Results and Discussion

The expansion of green zones is not merely a matter of landscape decoration, but rather a fundamental pillar of urban ecological sustainability. It serves to ensure harmony between human health, nature, and technology.



Figure 3. Green facade and roof systems for ecological residential buildings
Source: Prepared by the author

In addition, planning principles based on the mahalla system are considered an important factor in improving the social environment [10]. The communal living atmosphere, inner courtyards, and pedestrian areas formed in historical mahallas strengthened social relationships among residents. However, in modern residential complexes, the reduction of such social spaces negatively affects the quality of life of the population.

Therefore, when designing mid-rise residential buildings under the climatic conditions of Uzbekistan, the following tasks are considered especially important:

- preservation of national traditions;
- ensuring ecological sustainability;
- improving energy efficiency;
- applying natural ventilation systems;
- increasing green areas.

An example of this approach can be observed in the following proposed mid-rise residential complex project[11]. The facade design incorporates fired brick, wood carving, and natural decorative materials, integrating national architectural traditions with modern architecture[12]. In addition, green roofs and green balconies provide ecological sustainability, energy efficiency, and a healthy living environment for residents[9]. The planning solutions of the project are aimed at creating pedestrian-friendly internal spaces and green public areas that enhance social activity. (Figure 4).



Figure 4. Mid-rise residential complex with green infrastructure
Source: Prepared by the author (AI visualization)

The formation of mid-rise residential buildings under the climatic conditions of Uzbekistan is considered one of the important directions of modern architecture and urban planning. During the research, it was determined that the sharply continental climate, extremely hot summers, cold winter weather, and ecological problems significantly affect residential architecture [13].

Traditional architectural solutions formed in historical mahallas serve as an important source of experience for modern architecture. Inner courtyard systems, ayvons (traditional terraces), shaded streets, and natural ventilation elements are effective tools for improving the microclimate and reducing energy consumption [14].

In the design of future mid-rise residential buildings, the following principles should be applied as fundamental approaches:

- ecological sustainability;
- energy efficiency;
- green architecture;
- preservation of national traditions;
- use of local materials. (*Figure 5*).



Figure 5. Residential project based on green architecture and natural ventilation principles

Source: Prepared by the author

In addition, urban planning solutions based on the mahalla system contribute to improving the social and ecological quality of the living environment [15], [16]. By integrating modern technologies with national architectural values, it is possible to create a comfortable, sustainable, and climate-responsive residential environment suitable for the conditions of Uzbekistan.

4. Conclusion

In conclusion, the formation of mid-rise residential buildings under the climatic conditions of Uzbekistan requires an integrated architectural and ecological approach. The research demonstrated that the sharply continental climate of the country, characterized by extremely hot summers, cold winters, dust storms, and strong solar radiation, directly influences the planning structure, energy efficiency, and environmental sustainability of residential buildings. Therefore, modern residential architecture should not rely solely on imported design models, but instead must be adapted to local climatic, cultural, and social conditions.

The study confirmed that traditional architectural solutions developed in historical Uzbek mahallas – including inner courtyards, ayvons, shaded pedestrian spaces, and natural ventilation systems – remain highly effective for improving the microclimate and reducing energy consumption. Reinterpreting these principles in contemporary architecture can significantly enhance ecological sustainability and residential comfort. Furthermore, the application of green architecture technologies such as green roofs, vertical landscaping, solar energy systems, and energy-efficient materials plays a crucial role in minimizing environmental impact and improving the quality of urban life. The use of local and climatically suitable construction materials, including fired brick and wood, also contributes to thermal efficiency and preservation of national architectural identity.

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