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PRINCIPLES OF FORMING RESIDENTIAL BUILDINGS IN THE MICROCLIMATE OF DESERT REGIONS

Assistant of Jizzakh Polytechnic Institute, **L.X. Abdusamatova**

Student of Jizzakh Polytechnic Institute, **S.A. Temirova**

Abstract *This article examines the influence of desert microclimatic conditions on residential architecture and the principles of developing energy-efficient housing in arid regions. The effects of high air temperatures, intense solar radiation, low humidity, and wind regimes on architectural and planning solutions are analyzed. Based on traditional architectural experience and modern energy-saving technologies, recommendations for designing residential buildings in desert areas have been developed. The results of the study are important for improving living comfort, reducing energy consumption, and creating environmentally sustainable architectural solutions.*

Keywords: *desert region, microclimate, residential building, energy efficiency, bioclimatic architecture, solar radiation, natural ventilation, courtyard house, environmental sustainability.*

Introduction

Today, global climate change and the rational use of energy resources require new approaches in the fields of architecture and construction. The development of energy-efficient residential buildings has become one of the most important challenges, particularly in arid and desert regions. A significant part of Uzbekistan's territory consists of desert and semi-desert areas characterized by high temperatures, intense solar radiation, low humidity, and strong winds.

The microclimate of desert regions directly affects the architectural design, planning structure, construction technologies, and energy consumption of residential buildings. Therefore, considering local climatic conditions during the design process is essential. The integration of traditional architectural experience with modern energy-saving technologies represents one of the key approaches to creating sustainable and energy-efficient housing.

Research Methodology

The study was conducted using methods of scientific literature review, comparative analysis, system analysis, and bioclimatic assessment. Climatic characteristics of desert regions and their influence on residential building design were examined. In addition, traditional housing typologies that historically evolved in Central Asian desert regions were compared with contemporary energy-efficient construction technologies.

Main Characteristics of the Desert Microclimate

Desert regions are characterized by the following climatic features:

- * Air temperatures reaching +40–45°C and above during summer;
- * Large daily temperature fluctuations;
- * Low relative humidity levels, typically between 15% and 30%;
- * High intensity of solar radiation;
- * Frequent dust storms and strong winds;
- * Minimal annual precipitation.

These climatic factors significantly influence the energy balance and indoor environmental quality of buildings. As a result, residential design in desert regions requires effective strategies for thermal protection and passive cooling.

Microclimatic Foundations of Traditional Residential Architecture

Traditional residential architecture in desert regions has evolved over centuries in response to harsh climatic conditions.

Courtyard-Based Planning

The internal courtyard has historically served as the central planning element of desert housing. Courtyards create a favorable microclimate through shading, vegetation, and water features, helping to reduce air temperatures and improve thermal comfort.

Thick Walls

Buildings constructed from adobe, mud brick, and rammed earth possess high thermal mass. These materials delay heat transfer during the day and release stored heat gradually during cooler nighttime periods.

Shaded Verandas and Galleries

Verandas and galleries provide additional living spaces during hot seasons while protecting occupants from direct solar radiation.

Compact Urban Form

Dense building arrangements and narrow streets create mutual shading, reducing heat gain and mitigating the adverse effects of the desert climate.

Principles for the Formation of Modern Residential Buildings

Modern energy-efficient housing in desert regions should be designed according to the following principles.

Optimal Building Orientation

Proper orientation of buildings relative to the cardinal directions helps minimize solar heat gain. South- and west-facing facades should incorporate shading devices to reduce overheating.

Natural Ventilation

Cross-ventilation strategies achieved through the placement of windows and openings on opposite sides of buildings enhance indoor air circulation and reduce reliance on mechanical cooling systems.

Thermal Insulation

The application of modern insulation materials in roofs and external walls improves thermal performance and stabilizes indoor temperatures throughout the year.

Landscaping and Green Infrastructure

Vegetation contributes to improving the microclimate by reducing ambient temperatures, filtering dust, and providing shading. Green spaces play a significant role in enhancing outdoor comfort.

Renewable Energy Utilization

Desert regions possess considerable potential for solar energy generation. The integration of photovoltaic panels and solar thermal collectors can significantly reduce energy consumption and operational costs.

Results and Discussion

The analysis demonstrates that the application of bioclimatic design principles substantially improves the energy performance of residential buildings in desert environments. Features such as internal courtyards, thick walls, natural ventilation systems, and solar protection devices effectively reduce cooling loads and enhance indoor comfort.

Furthermore, the integration of renewable energy technologies and energy-efficient construction materials contributes to lowering

operational energy demand and supporting sustainable development. The findings indicate that a combination of traditional architectural knowledge and modern technological innovations provides an effective framework for residential development in desert regions.

Conclusion

The microclimate of desert regions is one of the primary factors influencing the architectural formation of residential buildings. High temperatures, intense solar radiation, and dry winds necessitate the application of bioclimatic design principles to achieve energy efficiency and thermal comfort.

Traditional architectural solutions such as courtyard planning, thick walls, and shaded spaces remain relevant and can be effectively combined with modern energy-saving technologies. This integrated approach contributes to reducing energy consumption, improving living conditions, and promoting environmentally sustainable development in desert regions.

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