



**RELEVANCE AND PROSPECTS FOR
THE DEVELOPMENT OF
LIGHTWEIGHT CONCRETE
PRODUCTION IN THE CONDITIONS OF
THE REPUBLIC OF UZBEKISTAN**

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Annotation: *This article analyzes the relevance and prospects of lightweight concrete production in the Republic of Uzbekistan. Against the backdrop of the construction industry's need to improve energy efficiency, reduce material consumption, and enhance operational performance of buildings, lightweight concrete gains increasing importance. The article examines global and local experiences, highlighting the use of natural and technogenic lightweight aggregates such as perlite, vermiculite, ash, and expanded clay. Key factors driving the development of lightweight concrete in Uzbekistan include the country's harsh continental climate, energy-saving policies, local raw material reserves, and environmental challenges. The authors emphasize the necessity of widespread adoption of lightweight concrete technologies within the framework of the national "green" economy strategy, underscoring its economic, ecological, and social significance.*

Keywords: *lightweight concrete; energy efficiency; thermal insulation; technogenic aggregates; perlite; vermiculite; construction materials; environmental sustainability; green economy; heat protection; cost reduction; local raw materials; energy saving.*

Introduction

In the current conditions of construction industry development, the production of lightweight concretes is becoming particularly relevant, which is due to the need to increase the energy efficiency of buildings, reduce the material intensity of structures, and improve the operational characteristics of construction objects. The rise in prices for traditional energy sources and the tightening of requirements for thermal protection of enclosing structures stimulate the search for new solutions aimed at reducing heat loss and ensuring the durability of structures.

Lightweight concretes with reduced density and good thermal insulation properties allow for a significant reduction in load on load-bearing structures, reduce cement and steel consumption, and ensure compliance with modern energy-efficient construction requirements. The use of such materials is especially relevant for the construction of low-rise buildings, industrial facilities, reconstruction and superstructure of existing structures, where minimal load on the foundation is required with sufficient strength and durability of the structures.

Scientific interest in lightweight concretes is also related to the possibility of using various porous aggregates of natural and technogenic origin in their composition: expanded vermiculite, perlite, pumice, expanded clay aggregate, fly ash, microspheres, and other materials. This allows for not only expanding the functional capabilities of concrete mixtures but also solving environmental problems by involving industrial waste in secondary circulation. In particular, studies by Yu.M. Bazhenov and V.I. Kalashnikov [10], as well as B.M. Rumyantsev [11] showed that the use of local porous aggregates allows for a 20-35%

reduction in the thermal conductivity of concrete without significantly reducing its strength characteristics.

Thus, the production of lightweight concrete is an important area of construction science and practice, ensuring the rational use of raw materials and energy resources, reducing construction costs, and increasing the comfort and energy efficiency of buildings.

Global and domestic trends in the development of lightweight concrete

In global construction practice, the production of lightweight concrete is considered one of the key directions in the creation of energy-efficient and environmentally friendly materials. In recent decades, a steady increase in the use of lightweight concrete in residential, civil, and industrial construction has been observed in European, North American, and Asian countries. This is due both to the tightening of regulatory requirements for building thermal protection and the overall strategy for transitioning to "green" technologies.

Global trends:

In Europe, lightweight concretes based on perlite, vermiculite, and autoclave aerated concrete are actively used, which is related to the requirements of EU directives on energy conservation and CO₂ emission reduction. Studies by H. Schneider and G. Hauser (Germany, 2017) have shown that the use of autoclave aerated concrete in housing construction allows for a 25-30% reduction in heat energy consumption compared to traditional materials.

In Japan and South Korea, mixtures using technogenic porous aggregates have become widespread. According to the work of Y. Kim and S. Park (2020), adding abrasive ash to lightweight concrete not only

reduces costs but also improves its microstructure due to pozzolanic activity.

In the USA, there is a trend towards the use of high-strength lightweight concrete in bridge construction and high-rise housing construction, where the reduction of the mass of structures plays a crucial role. The works of S. Mindess and J. Darwin [13] indicate that the use of lightweight concretes with modified microspheres allows achieving a strength of more than 60 MPa at a density of less than 1800 kg/m³.

Domestic trends (CIS and Uzbekistan):

In the CIS countries and, in particular, in Uzbekistan, interest in lightweight concrete is also increasing. This is manifested in:

- expansion of the production of autoclave aerated concrete and foam concrete as the main materials for low-rise construction;
- introduction of new thermal insulation and structural-thermal insulation concretes based on expanded clay aggregate, perlite, vermiculite, and ash;
- development of a regulatory framework reflecting the requirements for the strength, density, and thermal conductivity of lightweight concrete;
- state policy to improve the energy efficiency of buildings.

Studies by U.B. Kurbanov (2021) show that the use of lightweight concrete in Uzbekistan's housing construction allows for a 12-15% reduction in material costs while simultaneously increasing the energy efficiency of buildings. The works of B.B. Mirzayev (2019) prove the presence of significant reserves of perlite and vermiculite in the Tashkent, Navoi, and Kashkadarya regions, which creates a real raw material base for large-scale production.

In Russia, fundamental research on lightweight concretes has been conducted by B.M. Rumyantsev and I.A. Ivanov [11], who developed a classification of lightweight concretes and demonstrated the possibilities of using TPP ash as an effective aggregate. In Uzbekistan, similar research is being conducted by F.H. Yuldashev (2020), who substantiated the rational use of Navoi and Talimarjan TPP ash in thermal insulation concretes.

Thus, both in global and local practice, there is a steady trend towards increasing the share of lightweight concretes in construction, which is related to their technological, economic, and environmental advantages.

Analysis of the need to develop the production of lightweight concrete in the Republic of Uzbekistan

The construction complex of the Republic of Uzbekistan has demonstrated stable growth in recent years. According to the State Statistics Committee, over 10 million square meters of housing and social facilities are commissioned annually in the country (2022). [4]. Active urbanization, state programs for the construction of affordable housing and the modernization of infrastructure require the introduction of efficient building materials that ensure high operational characteristics and low cost.

Special attention is paid to energy efficiency issues in sectoral strategies. Within the framework of the "Strategy for the Transition of the Republic of Uzbekistan to a "Green" Economy for 2019-2030" [1] and the "Energy Saving Program in Construction" [2], it is planned to reduce the energy intensity of GDP by 30% by 2030 and increase the energy efficiency of buildings to the level of international standards. This is

directly related to the need to use lightweight concretes that can significantly improve the thermal insulation properties of enclosing structures.

1. Climatic conditions. Uzbekistan's sharply continental climate with hot summers (up to +45 °C) and cold winters (up to -25 °C) requires the use of building materials with high heat-protective properties. Research by A.A. Abdullayev and Sh.Kh. Khodzhaev (2021) [3] showed that the use of lightweight concrete in residential construction allows for a 30-40% reduction in building heat loss compared to traditional heavy concrete.

2. Energy saving and state priorities. The energy balance of Uzbekistan is characterized by a high share of natural gas - more than 70%, a significant part of which is spent on heating the housing stock [4]. According to F.Kh. Yuldashev's calculations (2020), the use of lightweight concrete with added ash can reduce the thermal conductivity of exterior walls to 0.18-0.22 W/ (m · K), which can save up to 15-20% of gas used for building heating.

3. Reducing construction costs. Due to their low density, lightweight concrete reduces the load on the foundation and allows for savings of up to 15-20% of cement and reinforcement [5]. The works of U.B. Kurbanov (2021) confirm that the use of lightweight concrete in mass housing construction in Tashkent and regional centers ensures a reduction in the total cost of 1 m² of housing by 8-12%.

4. Utilizing the local raw material base. Uzbekistan possesses significant reserves of natural porous materials. According to B.B. Mirzayev (2019) [8], large deposits of pearlite are located in the Tashkent and Navoi regions, vermiculite in the Kashkadarya region, and pumice

in the Fergana Valley. This creates prerequisites for the organization of local production of high-value-added lightweight concrete. In addition, Talimarjan, Navoi, and Angren Thermal Power Plants operate in the country, producing hundreds of thousands of tons of ash per year, which can be used as an active mineral component [7].

5. Ecological aspect. The use of technogenic aggregates (ashes, metallurgical production slags) in the composition of lightweight concretes allows for the solution of industrial waste utilization problems. Research by F.H. Yuldashev (2020) has shown that the use of Talimarjan TPP ash in lightweight concrete reduces the carbon footprint of cement material production by 12-15%, which corresponds to the international principles of "green construction."

6. Social significance. The use of lightweight concrete in housing construction provides more comfortable living conditions (thermal insulation, sound insulation, microclimate), which directly affects the quality of life of the population. Moreover, using local resources reduces construction costs and makes housing more affordable for the population.

7. Export potential. Uzbekistan has a favorable geographical location and can become a supplier of lightweight concrete and products based on them for the countries of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan), where the climatic conditions are similar. This opens up prospects for expanding the export potential of the construction industry.

Thus, the development of lightweight concrete production in Uzbekistan is a strategically important direction that ensures the implementation of state tasks for energy conservation, increasing the competitiveness of the construction industry, improving the

environmental situation, and creating conditions for the sustainable socio-economic development of the country.

In conclusion, the development of lightweight concrete production in the Republic of Uzbekistan is a strategically important direction in the construction industry, as it combines the solution of several key tasks at once: increasing the energy efficiency of buildings, rational use of the local raw material base, reducing construction costs, and improving the environmental situation. The analysis showed that in the country's sharply continental climate, lightweight concrete is capable of significantly reducing heat loss and creating comfortable living conditions for the population.

Global trends indicate that lightweight concretes are being actively introduced into residential, civil, and industrial construction due to their technological and operational advantages. Domestic experience also confirms the high effectiveness of using these materials, especially when using local porous aggregates and technogenic waste (ash, slag).

For Uzbekistan, the following are priority areas:

- development of local production of lightweight concrete based on available natural and secondary resources;
- improvement of the regulatory and technical framework in the field of design and application of structural and thermal insulation materials;
- stimulating scientific research to improve the composition and properties of lightweight concretes;
- expanding the use of innovative technologies in housing and infrastructure construction.

Thus, the production of lightweight concrete in Uzbekistan should be considered not only as a construction technology but also as an important element of the implementation of the state "green" economy strategy, contributing to sustainable socio-economic development and increasing the competitiveness of the national economy.

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