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GLOBAL AND DOMESTIC EXPERIENCE OF AERATED CONCRETE PRODUCTION AND THE POSSIBILITY OF USING LOCAL MATERIALS

ГАЗДАЛҒАН БЕТОН ӨНДІРІСІНІҢ ӘЛЕМДІК ЖӘНЕ ОТАНДЫҚ ТӘЖІРИБЕСІ ЖӘНЕ ЖЕРГІЛІКТІ МАТЕРИАЛДАРДЫ ҚОЛДАНУ МҮМКІНДІГІ

МИРОВОЙ И ОТЕЧЕСТВЕННЫЙ ОПЫТ ИЗГОТОВЛЕНИЯ ГАЗОБЕТОНА И ВОЗМОЖНОСТЬ ПРИМЕНЕНИЯ МЕСТНЫХ МАТЕРИАЛОВ

Abstract. *The relevance of the selected research topic is due to the fact that today aerated concrete is one of the most demanded building materials worldwide. Currently, the total output of aerated concrete and products from it exceeds 100 million cubic meters per year.*

In addition, aerated concrete has a low, compared to other concretes, production cost, especially products produced on the basis of ash and slag waste, and this makes the material even more popular for developers.

All of the above shows the importance of studying the issues of technology of aerated concrete production on the basis of ash and slag wastes and the study of initial properties of raw materials for aerated concrete.

The aim of the study is to investigate the possibility of using ash and slag waste and local natural resources for the production of aerated concrete, based on world and domestic experience.

The basic requirements to raw materials for aerated concrete are given. On the basis of the conducted scientific and practical researches the possibilities of production of cellular aerated concrete with the use of local sand and ash and slag wastes of Ust-Kamenogorsk Thermal Power Plant are revealed. These raw materials meet all the requirements for materials according to GOST 25485-2019 "Cellular concretes. General technical conditions". The results of research allowed to recommend ash and slag as a silica material for the production of aerated concrete.

Keywords: *aerated concrete; ash and slag waste; cellular concrete; autoclaved concrete; non-autoclaved concrete; gasifier; seismic stability.*

Аңдатпа. *Таңдалған зерттеу тақырыбының өзектілігі бүгінде газдалған бетон бүкіл әлемде ең көп сұранысқа ие құрылыс материалдарының бірі болып табылатындығына байланысты. Қазіргі уақытта газдалған бетон мен одан жасалған бұйымдардың жалпы шығарылымы жылына 100 млн. текше метрден асады.*

Сонымен қатар, газдалған бетонның басқа бетондармен салыстырғанда өзіндік құны төмен, әсіресе жергілікті табиғи материалдар мен күл-қож қалдықтарынан өндірілетін өнімдер және бұл материалды әзірлеушілер үшін одан да танымал етеді.

Жоғарыда айтылғандардың барлығы күл-қож қалдықтары негізінде газдалған бетон өндіру технологиясының мәселелерін зерттеудің маңыздылығын көрсетеді.

Зерттеудің мақсаты – әлемдік және отандық тәжірибеге негізделген газдалған бетон өндіру үшін күл-қож қалдықтары мен жергілікті табиғи ресурстарды пайдалану мүмкіндігін зерттеу.

Газдалған бетондарға арналған шикізатқа қойылатын негізгі талаптар келтірілген. Жүргізілген ғылыми және практикалық зерттеулер негізінде Өскемен ЖЭО-ның күл-қож және жергілікті құмды пайдалана отырып, ұялы газбетондарды өндіру мүмкіндіктері анықталды. Бұл шикізаттар МемСТ 25485-2019 «Ұялы бетондар. Жалпы техникалық шарттар» бойынша материалдарға қойылатын барлық талаптарды қанағаттандырады. Зерттеу нәтижелері күл- қожды газдалған бетон өндірісі үшін кремнийлі материал ретінде ұсынуға мүмкіндік берді.

***Түйін сөздер**: газдалған бетон; күл-қож қалдықтары; ұялы бетондар; автоклавты бетон; автоклавсыз бетон; газ түзуші; жер сілкінісіне төзімділік .*

***Аннотация.** Актуальность выбранной темы исследования обусловлена тем, что сегодня газобетон является одним из самых востребованных строительных материалов во всем мире. В настоящее время суммарный выпуск газобетона и изделий из него превышает 100 млн. куб. м в год.*

Кроме того, газобетон имеет низкую, по сравнению с другими бетонами, себестоимость, особенно продукция, вырабатываемая на основе местных природных материалов и золошлаковых отходов, и это делает материал еще более популярным для застройщиков.

Все вышеизложенное показывает важность изучения вопросов технологии производства газобетона на основе золошлаковых отходов и исследование исходных свойств сырьевых материалов для газобетона.

Целью исследования является – исследование возможности использования золошлаковых отходов и местных природных ресурсов для производства газобетона, основанное на мировом и отечественном опыте.

Приведены основные требования к сырью для газобетонов. На основе проведенных научных и практических исследований выявлены возможности производства ячеистых газобетонов с использованием местного песка и золошлаковых отходов УК ТЭЦ. Данные сырьевые материалы удовлетворяет всем требованиям, предъявляемым к материалам по ГОСТ 25485-2019 «Бетоны ячеисты. Общие технические условия». Результаты исследований позволило рекомендовать золошлак как кремнеземистый материал для производство газобетона.

***Ключевые слова:** газобетон; золошлаковые отходы; ячеистые бетоны; автоклавный бетон; неавтоклавный бетон; газообразователь; сейсмоустойчивость .*

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***Keywords:** aerated concrete; ash and slag waste; cellular concrete; autoclaved concrete; non-autoclaved concrete; gasifier; seismic stability.*

Introduction. Due to the unique technological characteristics of aerated concrete products are widely used in construction, including the construction of buildings in earthquake-prone zones. For Kazakhstan the problem of increase of seismic stability of buildings and constructions is extremely acute. For example, seismicity of construction areas in the territory of Ust-Kamenogorsk city reaches 7 points [1], which requires mandatory calculation and analysis of seismic effects on the basis of SP RK 2.03-30-2017 «Construction in seismic zones of the Republic of Kazakhstan» [2]. Gas concretes are 60-85% by volume composed of closed pores

0.2-2 mm in size. Concretes are produced by curing a mixture of binder, silica component and water saturated with gas bubbles. Due to the highly porous structure, the average density of cellular concrete is low 300-1200 kg/m^3; it has low thermal conductivity with sufficient strength. Concretes with desired characteristics can be obtained relatively easily by adjusting their porosity during the manufacturing process.

Portland cement with silica component can serve as a binder in aerated concrete. Silica component is silica sand, blast furnace slag, ash from thermal power plants and others. The silica component reduces the consumption of binder and reduces the shrinkage of concrete. The use of by-products for these purposes is economically advantageous and environmentally friendly. The ratio between the silica component and the binder is determined by experience.

The advantage of aerated concrete is that they have good sound insulation properties, they are fire resistant and easy to be mechanically processed. The most rational area of application of cellular concrete is enclosing structures of residential and industrial buildings.

The main component of the investigated aerated concrete is quartz sand, portland cement, ash and slag from Ust-Kamenogorsk thermal power plant.

One of the promising directions for obtaining new generation concretes characterized by high manufacturability, increased physical, mechanical and operational properties is the use of activated reaction-powder raw material mixtures with fine fillers of different nature and dispersity [3].

The effectiveness of using such materials as microsilica, fly ash, metakaolin, microsilica, stone flour (limestone and quartz) as fine fillers for concrete production has been shown in a number of studies. These fillers bind the hydrolyzed lime of Portland cement already in early hydration (after 1-2 days of curing). An increase in early strength is observed in concretes with all microfillers [4].

Therefore, for aerated concrete it is advisable to use other aggregates, providing the achievement of the necessary characteristics of concrete within the established norms of cement consumption. In this regard, attention should be paid to the possibility of using additives and concrete aggregates prepared using ash and slag wastes of Ust-Kamenogorsk thermal power plant. It should be noted that the resource in the form of ash and slag wastes on the territory of East-Kazakhstan region and other regions of Kazakhstan is not limited, although their properties in different dumps can have significant differences.

The aim of the work is to study the possibility of using ash and slag waste, local natural resources Kurgan quartz sand and cement «Bukhtarma Cement Company» for the production of aerated concrete, based on world and domestic experience.

As the tasks of the study defined:

1) literary analysis of world and domestic experience in the production of aerated concrete;

2) based on the analysis of the choice of raw materials for the production of aerated concrete using local resources;

3) determination of the characteristics of the selected materials.

Literary review. The history of the invention of aerated concrete dates back to 1889, when it was first obtained by a young scientist Erik Hoffmann (Czech Republic). Erik Hoffmann obtained the first aerated concrete by adding chloride and carbon dioxide salts to cement and gypsum mortar. The latter, interacting with the cement mortar and swelling it, provided a porous structure of concrete. The resulting porous material was called aerated concrete by Hoffmann. However, Goffman's invention at the end of the XIX century did not find practical application; a number of scientists and industrial scientists paid attention to Goffman's research almost 15 years later [5].

The next stage in the development of aerated concrete production was in 1914, when American scientists Aulsworth and Dyer proposed to use finely ground aluminum as a gas-forming agent, which reacts with calcium hydroxide to release hydrogen and acts as a pore-forming agent. The use of aluminum powder has revolutionized the mass production of aerated concrete. Aluminum powder is widely used as a powdering agent even today.

The invention of Aulsworth-Dyer can be called the beginning of large-scale production of aerated concrete.

In 1921, Swedish scientist and architect Johan Axel Eriksson proposed to supplement the aerated concrete production process with autoclaving. Eriksson proposed porous mixture of quicklime and fine silica component with the addition of 10% cement. In Eriksson's experiments, the reaction of aluminum powder with aqueous calcium solution was used to porize the mixture. Eriksson is rightly considered to be the «father» of autoclaved aerated concrete and other lightweight concrete production technology [6].

In 1922, German scientists Adolf and Paul applied hydrogen peroxide (perhydrol) to poritize the concrete mixture, but in the 1920 perhydrol was not widely used in the technology of aerated concrete production; later, in the middle of the twentieth century and now in some industries perhydrol began to be used as a blowing agent for cement mortars.

The products from aerated concrete obtained in the analyzed period were characterized by low crack resistance and operated without protective coatings even in conditions of high humidity and exposure to aggressive media, the material quickly destroyed, lost its strength properties, i.e. had low technological and physical-mechanical characteristics. The protection of aerated concrete structures from destruction and harmful effects in the form of vapor permeable dense layer of cement-sand mortar used in a number of industries did not provide the necessary quality of the material. The accumulation of moisture at the boundary of aerated concrete - cement-sand mortar inevitably led to the destruction of the product during one and a half or two years of operation. A serious problem for a long time was the protection of steel from corrosion in aerated concrete reinforced structures.

Therefore, the research of scientists in the 1920 was focused on the problem of providing protection of aerated concrete and its products from the harmful effects of moisture, aggressive media, improving the strength and performance characteristics of the material.

The next important milestone in the history of aerated concrete was the use of heat and humidity treatment (HWT) - steaming of products in autoclaves [7].

The first company to apply autoclave method of aerated concrete production on an industrial scale in 1929 was the German company «Ytong». The production capacity of the company in 1929 amounted to 15.5 thousand cubic meters per year, and in 1931 this figure doubled.

Thus, by the mid-1930, two technologies for the production of aerated concrete products were developed abroad, which exist to this day - autoclave and non-autoclave methods.

Substantial improvement of aerated concrete properties led to the fact that in the period up to 1939 the volume of aerated concrete production in Western Europe steadily increased, and the technique and technology of production of aerated concrete products were constantly improving.

However, during World War II, the output of aerated concrete products in Europe decreased by an average of 4 times, and research and development studies in the field of construction materials for civil engineering in most Western countries were practically stopped.

After the Second World War, the production of aerated concrete increased significantly. Half-destroyed Europe and Great Britain were in urgent need of large volumes of building materials with minimal production costs, which led to the rapid development of concrete production technologies, including aerated concrete and aerated concrete wall products.

Since 1948, a steady growth in the production of aerated concrete products began in Western Europe.

The leader in the production of aerated concrete products in the post-war years is Sweden, where by 1964 the volume of production of reinforced aerated concrete structures amounted to 1.6 million cubic meters, which is twice the level of 1948.

The Federal Republic of Germany was not significantly behind Sweden, where the production of aerated concrete began to develop rapidly in the post-war period. In the mid-1950s, the first plants for the production of wall panels and blocks of aerated concrete came into operation in the FRG, and by 1966 the production of aerated concrete products in the FRG increased to 1.25 million cubic meters. m. In the structure of production of aerated concrete produced in the FRG, almost half of the panels and floor slabs, and the rest of the volume was aerated concrete blocks [8].

If we turn to foreign experience of production of aerated concrete and other building materials on the basis of ash and slag wastes, we can note several main trends. With the accumulation of large volumes of anthropogenic waste in the early 1960 in developed countries began to actively study the problems of organization of waste-free production and waste utilization for the needs of the construction industry. Especially wide application in the countries of Europe (Austria, Belgium, Poland, etc.) and the USA found ashes from coal and oil shale combustion.

Since 1960, fly ash from thermal power plants in European countries, USA, Canada, Turkey, etc. has been used for production of cements and light porous aggregates.

According to the data of reviews on ash utilization published by the Edison Electric Institute (EEI), it can be seen that in the second half of the twentieth century the volume of ash and slag application in the USA increased annually: in 1965 it was 1 million tons, in 1975 - 10 million tons, in 1985 - 42 million tons. At that, the main consumer of ash and slag was the construction industry. There are data on construction of objects built of concrete made on the basis of fly ash, for example, underwater structures in the state of Alabama, Ridgeland power station, 38-storey skyscraper in Chicago. Concretes based on fuel slag are used to produce slag pumice for road construction in the USA. There is no data on mass production of gas concrete from ash and slag in the USA.

In Great Britain fly ash was widely used in the second half of the twentieth century for production of concrete used in power engineering construction (for example, Ferrybridge power station, main building of Abertau power station). British company «Thermolight Eatong Company», since 1970, specializes in the production of gas-ash concrete, its annual output at 10 plants of the company was in different years from 1.1 to 3 million cubic meters.

Since 1980, as a result of transition to «Green economy» and tightening of environmental requirements, the share of coal-fired thermal power in Western Europe, Great Britain and the USA has been steadily decreasing, which led to a significant reduction in the volume of technogenic waste and its role in the production of building materials and products by the early 2000.

Turning to the domestic experience of production of aerated concrete and products from it, we can state that the first studies of production technology and properties of lightweight concrete in our country date back to 1930-1935. The greatest contribution to the development of aerated concrete technology was made by Soviet scientists B.N. Kaufman, I.T. Kudryashov, P.A. Rebinder, A.F. Chudnovsky, E.S. Silaenkov, K.F. Fokin, A.G. Neiman, B.Z. Chistyakov and others.

The first large-scale production of autoclaved products in the USSR began in 1939 in Novosibirsk.

In 1940, I.T. Kudryashov and his co-workers developed a method of manufacturing products from autoclaved gas silicate using quicklime and finely ground sand. Kudryashov showed the advantages of autoclaved concrete over non-autoclaved concrete [9].

B.T. Kevesh investigated the possibilities of using perhydrol for mass production of aerated concrete products (wall panels and floor slabs).

A.T. Baranov and G.A. Buzhevich substantiated the method of production of aerated concrete on the basis of fly ash.

Although the first experimental batches of aerated concrete were obtained in the pre-war period, mass production of aerated blocks in the USSR was launched only after the end of World War II. Since the 1950, the volume of aerated concrete production in the USSR has been steadily increasing, and Soviet scientists have not stopped improving this material, minimizing its negative properties. In many cities of the Soviet Union, entire residential neighborhoods made of gas-silicate were erected [10].

Research work in the field of lightweight concrete expanded considerably in the postwar period. Studies of Soviet scientists in the second half of the twentieth century were carried out in two directions:

1) utilization of industrial wastes, first of all, ash and slag for aerated concrete production (F.G. Kiviselg, B.Z. Chistyakov, etc.);

2) development of technological parameters of cellular concrete products manufacturing, including modes of their heat treatment (E.S. Silaenkov, E.Y. Eshler, P.A. Rebinder, etc.).

At present there is a number of research works showing the feasibility of using ash and slag wastes as a binder in aerated concrete mixture. Aerated concrete is made of cement with the addition of ground sand, ash with the use of aluminum powder or hydrogen peroxide as gas formers [11].

In [12] the influence of technology of ash-containing dry mixes for the production of non-autoclaved aerated concrete on its properties was studied. Introduction of 10-20 % of silica sand into the ground ash-cement mixture allows to obtain aerated concrete with density of 700 kg/cubic meter and compressive strength of 2.76-3.02 MPa.

It was shown in [13] that sodium silicate is an effective curing gas pedal in the composition of dry mixtures. The strength, shrinkage and frost resistance of aerated concrete meet the regulatory requirements [14], [15], [16] and others.

In the laboratory of concretes of the Building Materials Technology Department of the Institute of Chemistry and Technology of Rare Elements and Mineral Raw Materials. I.V. Tananaev Institute of Chemistry and Technology of Rare Elements and Mineral Raw Materials KSC RAS (IKHTREMS KSC RAS) laboratory and pilot works on the use of ash-and-slag mixture (ASM) of Apatitskaya TPP for the manufacture of aerated concrete and other cellular materials were carried out.

Studies [17] have shown that ash and slag ash is a low-calcium acid ash with basicity modulus 0.07. Due to high-temperature combustion of coal in a fine ground state and long-term storage in the ash dump, APEC ash and slag ash is characterized by homogeneity of chemical and mineral compositions. Ash ash grains have a stable structure against silicate and ferruginous decomposition. In the experiment ash and slag sieved through a sieve with 5 mm mesh was used. As a gas-forming additive scientists of ICHTREMS KSC RAS used aluminum powder of PAP-1 grade in the form of aqueous suspension with the addition of surfactant in the amount of 5% of the powder mass. As a result of experimental studies the team of ICHTREMS KSC RAS developed compositions and studied physical and mechanical properties of autoclaved and non-autoclaved curing gas concrete. The obtained aerated concrete fully meet the criteria of GOST 25485-89 [18].

It should be noted that many new production technologies are being developed to improve the quality of aerated concrete. These include:

– activation of aerated concrete mixture components;

– vibration effect on the concrete mixture;

– reinforcement with fiber components;

– modification of the concrete mixture with additives;

– activation of the concrete mixture by exposing it to electrical energy.

The most promising method of activation is considered to be the one that allows to obtain aerated concrete of maximum possible porosity without loss of strength.

Thus, the history of production of aerated concrete and products from it has more than a hundred years. All these years the technological and physical-mechanical properties of aerated concrete and technologies of production of building products from it have been improved.

Materials and methods of research. Aerated concrete refers to cellular concrete and is characterized by the fact that it is manufactured using a gas-forming agent.

The main components of aerated concrete are binder, aggregate (filler), gas-forming agent, porous structure stabilizer and water for mixing.

Cement and lime can be used as binders for the preparation of aerated concrete.

It is recommended to use Portland cement without additives trepel, gliezha, trace, clay, opoki ash, containing tricalcium aluminate (C3A) not more than 6% with the beginning of setting not earlier than 2 hours and ending not later than 4 hours. In addition, the fineness of grinding, specific surface area, true and bulk density, uniformity of volume change, compressive and flexural strength should be determined and controlled.

Calcium quicklime for aerated concrete is recommended to use fast and medium quenching lime with a quenching speed of 5 to 25 minutes. The content of active oxides of calcium (CaO) and magnesium (MgO) should be at least 70%. Overburning of lime is limited, it should not exceed 2%. The fineness of lime grinding should be with a specific surface area of about 6000 cm^2/g. It is also obligatory to determine and control the true and bulk density, uniformity of volume change.

Since one of the main tasks is to model the composition of aerated concrete suitable for use in seismically hazardous areas, strength is one of the most important indicators. Therefore, it was decided to use Portland cement of CEM I 52.5H grade as a binding material.

As a silica component is used:

– quartz sand that meets the requirements of GOST 8736-2014 with a quartz content of not less than 85%, mica not more than 0.5%, silty and clay impurities (not more than 3%), montmorillonite clay impurities (not more than 1.5%). It is allowed to use feldspar sand with quartz content not less than 60%. It is possible to use river or quarry sand, where the fraction size: 0,1 mm - 0,5 mm.

– fly ash from thermal power plants with electrostatic precipitators from combustion. Fly ash should have vitreous and melted particles not less than 50%. It is necessary to determine the grain composition of slag, specific surface area, bulk density and density of grains of slag component - in dry state, uniformity of volume change.

A water suspension of aluminum powder is used as a gas-forming agent. Aqueous suspension should be made of aluminum powder PAP-1, meeting the requirements of GOST 5494 «Aluminum powder. Technical conditions» or paste, prepared on the basis of powder PAP-1, in conditions ensuring explosion safety.

Calcined soda ash according to GOST 2263-79 is used as a stabilizer to regulate the process of structure formation and plastic strength growth. Consumption of stabilizer is assigned depending on the type of binder and specified by experience.

To prepare the mixture, water is required, which must meet the requirements of GOST 23732-79. For sufficient gas formation and lifting of the mixture, water should be preheated to 50-60 °C. High temperature of the mixture will lead to an active reaction of gases, which is necessary for obtaining high-quality aerated concrete.

In this paper the physical and mechanical properties, quality of raw materials for the production of aerated concrete are investigated. The objects of the study were selected ash and slag wastes of UK thermal power plant, portland cement of Bukhtarma cement company, quartz sand of Kurgan deposit.

Standard test methods corresponding to GOST and other regulatory documents were used to determine the characteristics of initial materials.

Results and their discussion. Laboratory studies within the framework of this work were conducted on the basis of the Center of competence and technology transfer in the field of construction EKTU D. Serikbayev (Ust-Kamenogorsk, Kazakhstan), and the portland cement of Bukhtarma cement company was investigated.

The results of the tests are shown in Table 1.

Table 1. Physical and mechanical parameters of Portland cement of CEM I 52,5H grade

Name of indicator	Actual values of indicators
Grinding fineness by specific surface area, %	9
True density, kg/m^3	3191
Setting time, min	Start – 160m; End – 240 min
Uniformity of volume change, mm	7,2
Flexural strength at the age of 28 days, MPa	9,9
Compressive strength at the age of 28 days, MPa	64,5

The chemical and mineralogical composition of Portland cement clinkers is given in Table 2 and Table 3.

Table 2. Average chemical composition of Portland cements used in the studies

Name of cement	Oxide content, %					
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3
Bukhtarminskaya Cement Company	19,95	5,58	4,98	63,07	4,5	0,36

Table 3. Estimated mineralogical composition of cement clinker

Name of cement	Mineral content, %						
	C_3S	C_2S	C_3A	A_4AF	Mg_2O	K_2O	l.o.i
Bukhtarminskaya Cement Company	59,1	12,3	6,3	15,1	0,03	1,02	0,87

Studies of fine aggregate of quartz sand deposits according to the results of preliminary testing showed good results in Table 4. Preliminary tests were conducted for the content of SiO_2, as well as silty and clay impurities in the sands.

Table 4. Basic parameters of quartz sand allowed for further testing

Name fields	Contents, %			Humidity, %	coarseness modulus
	SiO_2	Clay in clumps	Organic impurities		
Kurgan	90-96	0	lighter than the standard	0,2	1,025

Sand of Kurgan deposit contains more than 90 % SiO_2 (total) and consists mainly of quartz (SiO_2 unbound).

Ash and slag wastes of Ust-Kamenogorsk thermal power plant are generated by combustion of fuel (coal, fuel oil) in the furnaces of boilers. At coal combustion most of ash contained in it is carried away with boiler flue gases and is retained by ash collectors (coal ash). The remaining part of the ash contained in the fuel, during combustion falls out into slag (coal slag). The ash generated from fuel oil combustion is a dry mixture of ash and soot deposits.

The supplied waste meets safety requirements, including radiation safety.

Table 5 shows information on the chemical composition of ash and slag used for the preparation of experimental samples of aerated concrete.

Table 5. Chemical composition of ash and slag from Ust-Kamenogorsk thermal power plant, wt.wt. %

Sample name	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	SO_3	$Na_2O \cdot K_2O$
UK TPP ash and slag	51,27	22,49	9,32	2,95	1,69	0,95	0,93	4,67

Table 5 shows that technogenic raw material contains mainly free and bound compounds oxides of silicon, aluminum, iron, calcium, magnesium, potassium, sodium, sulfur.

Specific surface of ash and slag is 3500 cm^2/g and withstands tests on uniformity of volume change.

To obtain the pore structure of cellular concrete, gas and foaming agents are used, providing the given average density and the required physical and mechanical parameters of cellular concrete. The main gas-forming component used in plants for the production of aerated concrete in the CIS countries was pigmented aluminum powder (PAP-1 and PAP-2 grades), produced in accordance with GOST 5494.

Conclusion. Over the past 10-15 years, aerated concrete has become one of the most popular wall materials in our country. The share of aerated concrete in the market of masonry materials exceeds 50% and continues to grow.

The potential of aerated concrete as an effective building material in our country has not been realized, despite all the obvious advantages. Gas concrete has a low cost price compared to other concretes, but it is not inferior in physical, mechanical and operational characteristics, and in some cases it has higher indicators. Application in construction of aerated concrete materials and structures allows to increase seismic resistance of buildings and constructions, which makes the material in demand in earthquake-prone areas of construction in Kazakhstan.

Along with this, utilization of ash and slag waste is a promising direction for the development of small and medium-sized businesses, contributes to reducing the cost of construction products. In addition, the use of ash and slag waste for the production of aerated concrete allows to solve complex environmental problems in the areas of coal-fired thermal power plants, which is especially important for Ust-Kamenogorsk city, which has a thermal power plant.

Thus, on the basis of the studied experience of manufacture of aerated concrete and conducted researches the possibilities of application of local raw materials for manufacture of aerated concrete are revealed. Raw materials meet all the requirements for materials according to GOST 25485-2019 «Cellular concretes. General technical conditions» and can be used to produce products of the required quality.

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