Study of the Effect of Additives that Accelerate Solidification on the Main Properties of Foam Concrete

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Nowadays, light construction materials are widely used in the production of modern constructions and products. At a time when the demand for heat-insulating materials is increasing every year, the production of high-efficiency composite materials based on local and industrial waste can be one of the solutions to this problem. One type of these materials is foam concrete. In this article, the effect of solidification-accelerating additives on the main properties of foam concrete was studied and conclusions were drawn based on the obtained results.

Keywords: foam concrete, solidification-accelerating additives, heat-insulating materials, composite materials, light construction materials

Introduction Since the first years of independence, a number of positive works aimed at the development of the construction industry in our country, the production of modern, energy-efficient and high-performance construction materials, products and constructions based on local raw materials have been carried out. is being implemented [1-3]. Taking into account the huge energy consumption for the purpose of heating buildings, the issue of using heat-insulating and relatively cheap building materials in the construction of structures has become acute. One such material is foam concrete that does not harden in an autoclave. Using it as a wall material, it is possible to provide the necessary heat resistance through heat transfer methods with a small wall thickness [4-7]. Foam concrete that does not harden in an autoclave is considered as a solution to the problem of heating in residential buildings of the Republic of Uzbekistan, and it is a promising heat insulating material for the production of this material. It is characterized by reliability, durability, simplicity of technological solutions, low production costs. Foam blocks are becoming more and more popular as a reliable and energy-efficient material for construction around the world. In particular, they are popular in low-rise construction. Here, heat transfer foam blocks are becoming more and more popular due to their technological innovation, durability and a number of other factors, starting with easy installation features. Their service life is almost unlimited, and if the construction process is in the right sequence, if it is made of quality concrete construction, it will serve for many years, the building will ultimately be strong and reliable. [8-11]. In the domestic market, foam concrete appeared a long time ago, but even though foam blocks have been used in Europe for more than ten years, many consumers still have doubts about the quality of foam, its reliability and environmentally friendly material. is not aware of it, but it's all about the unconventionality of new materials in domestic consumption. Foam blocks in construction successfully replace brick, often surpassing it in terms of mechanical and physical properties. It shows itself well as a building material for low-rise houses or multi-story houses. Nowadays, light construction materials are widely used in the production of modern constructions and products. For example, using lightweight heat-insulating concrete instead of heavy concrete in the construction of a building can reduce the total weight of the building by 5 times, as a result, the total cost of the building will be saved. At a time when the demand for heat-insulating materials is increasing every year, the production of high-efficiency composite materials based on local and industrial waste can be one of the solutions to this problem. One type of these materials is foam concrete. Materials and methods Currently, as energy prices are increasing day by day, its economy is one of the problems that need to be solved. In solving this problem, the use of heat-protecting materials is very effective. Foam concrete can be added to the list of such materials. In the Republic of Uzbekistan, the construction industry is considered one of the most important sectors of the economy and ranks among the first in terms of the use of natural raw materials. Today's manufacturing industry requires solving issues such as rational use of raw materials and energy resources, development of low-waste or zero-waste technologies [12-15]. The use of heat and noise protection materials in the construction of manufacturing industry and public buildings leads to a reduction in the thickness, weight and consumption of raw materials (cement, brick, metal) of structures. In addition, the cost of construction will be reduced to a certain amount. In the production of aerated concrete, foam concrete produced without the autoclave process is currently more important, because there are organizational advantages of production: low capital costs are required, energy-efficient technology and the absence of the autoclave process. In addition, the low cost of transportation leads to a decrease in the price and competitiveness of the products produced by large-capacity aerated concrete plants. This situation shows that the production of autoclave-free foam concrete in low-capacity factories and construction sites is more economically efficient. At the same time, the production of foam concrete with the most effective thermophysical parameters of low average density is problematic due to the complexity of ensuring a stable cellular structure and high strength. It is known that it is permanent increasing the strength in density can be achieved only by increasing the strength of the foam concrete matrix, in particular, by increasing the activity of binders, reducing the ratio of water hardness, using chemical modifiers, mechanical chemical activation of binders, etc. The use of these methods can significantly complicate the technological process, so their implementation should be feasible from the technical and economic point of view.

One of the methods of obtaining high-quality foam concrete is the use of additives that accelerate the hardening process and fast-hardening binders. The use of the above technological methods does not require large costs [16-21]. Foam concrete can be successfully used in the preparation of precast concrete and monolithic constructions. In contrast to aerated concrete, the production of foam concrete uses technology without autoclave, which consumes less energy. In addition to the simplicity of the production technology of foam concrete, there are other advantages, which is that it has a positive content. But despite this, manufacturers face some difficulties. These are non-bonding of the foam with the binder, non-homogeneity of the foam concrete, large settlement, cracks due to internal stress, etc. At the stage of mixing the components of the foam concrete mixture, experts set the initial mixing time of dry mixtures until the mixture reaches a constant mass. This time was determined on the basis of many laboratory tests. Due to research on the mixing mode, the optimal composition for foam concrete was selected. Before mixing the components, it is necessary to pay attention to the following:

- the mixing process significantly affects the quality of the product made of foam concrete compared to the product made of ordinary concrete;
- mixing determines the density of the material and distributes the porosity;
- the mixing period directly affects the

strength and density of the mixture;
 extension of the mixing time in the production of cellular and lightweight concretes leads to an increase in the volume of the foam in the concrete, and then to a decrease.

According to the conducted experiments, foam concrete produced without heat treatment is mixed in the following sequence: powdery ETF slag + fly ash + aqueous mixture of the component (mixing 1.5 minutes).

The total time of mixing the mixture for the preparation of foam concrete is set to 3 minutes. The foam prepared by the foam generator is added to the concrete mixture in the concrete mixer brought to a constant mass. The construction of the mixer affects the properties of the foam mixture, as it affects the properties of ordinary concrete: the final quality indicators of the product depend on it [22-27].

This has a significant effect on the properties of concrete, it is impossible to use a different type of mixer during the production process using one type of mixer. The speed of mixing and the shape of the teeth in the mixer are important. If the process of pore formation has already been carried out, then the centripetal force causes deformation: the size of the pore increases and the shape of the formed bubbles changes. Experiments show that mixing dry components - cement, fly ash in a mixer takes an average of 1.5-2 minutes until a stable mass is formed. Then an aqueous mixture of the (alkaline) component is added to the mixer. The total mixing time is 5 minutes. Extending the mixing time does not increase the strength of foam concrete and is economically ineffective. And reduction impairs the homogeneity of the mixture and leads to a decrease in strength [28-31].

According to the results of production technology of foam concrete with hydraulic binder without autoclave, this technology consumes less energy and labor, at the same time, it increases the quality of the product. This method, proposed for the production of foam concrete products, allows us to obtain external and internal wall blocks, as well as heat-insulating plates. The production of wall blocks using foam concrete is reflected in the next scheme, this technology is very different from the technology that has other reinforcement elements. The technological scheme reflected the department for preparation and storage of raw material components, the department for the preparation of foam concrete mixture, the molding station, the post for the durability of the product in the mold, the post for releasing the product from the mold, and the warehouse for finished products. Usually, in these cases, the veil is removed and the mixture is fully covered It is laid according to jm, and then a large-sized block is made (1000x1000x600 mm). In the following years, 1000x500 mm heat-insulating foam concrete slabs are being prepared from this block, the thickness of which is chosen according to the customer's proposal. In addition, it should be said that foam concrete heat-insulating plates are made of very light foam concrete. Very efficient to build and very difficult to master in production. The complexity of the production of lightweight foam concrete without sand depends on its low strength on the first day and its tendency to sink and crack.

Production of products without heat treatment. The developed technology consists of the following processes:
 preparation of foaming composition;
 foam production;
 preparation of binder mixture;
 preparation of foam concrete by mixing foam with binder mixture;
 filling the mold.

Today, the production of foam blocks occupies a leading position in the production of lightweight concrete. The technological process of making foam concrete blocks is very simple, but most manufacturers waste several tons of cement before starting the production of quality foam blocks. It's all about production equipment and raw materials.

Foam concrete is made with uniform distribution of air bubbles throughout the mass. Unlike aerated concrete, foam concrete is made not by chemical bonding, but by mechanical processing. Foam is obtained by mixing water with surfactants.

The production of autoclaved foam concrete is characterized by the simplicity of equipment and production technology, which allows production to be carried out in landfill and factory conditions. In addition to its simplicity, foam concrete has many other positive properties.

For example, in the process of its production, it is not difficult to give this material the required density index.

The main raw materials in production are cement and foaming agents. For the preparation of foam concrete that does not harden in an autoclave, Portland cement and pozzolan cement of the brand no less than M400 are used. The use of portland cements with a brand lower than M400 leads to a decrease in the strength of foam concrete. Increasing the strength of foam concrete by increasing the consumption of cement leads to an increase in its volumetric weight and a decrease in thermal insulation properties.

Choosing the right water-cement ratio plays an important role in the production of foam concrete. The optimal water-cement ratio is determined by achieving certain flowability indicators of the recorded foam concrete mass [32-36]. In the production of foam concrete, the following requirements are imposed on the water solution:

It should not be contaminated with kerosene, oil and other substances, and should not contain a large amount of salt and calcium, and should not be hard.

According to the production method, the equipment is divided into 3 different categories: "Stabilizers", mixers working with foam transfer from the foam generator, and dry mineralization of foam.

The difference of barotechnology is that foaming agent concentrate, water, cement, sand and additives are transferred directly to the mixer. 1.8 atm in the mixer. the foam concrete mass is mixed under pressure for 3-5 minutes. Then the ready-made foam concrete is transferred to the construction site or molds by air pressure.

It is difficult to control and regulate technological processes in the formation and production of cellular concrete macrostructure. It is related to the control of many technological parameters in the production and solidification of the product: the quality and quantity of raw materials, the level of water hardness ratio, the temperature and pH value of the environment. Therefore, the actual conditions for the formation of foam concrete structures often differ from the optimal ones, which leads to the appearance of defects in the structure.

If the foaming agent and the type of binder, as well as the methods of obtaining the foam and mixing it with solid components, are incorrectly selected, the foam often breaks before the binder solidifies, the foam-cement mass may shrink and continuous foam-synthesis channels may be formed along the height of the mass. As a result, the structure of foam concrete is damaged, its density increases, and the unevenness of the thermophysical properties of the product increases.

The processes occurring in the foam-cement mass are described by the laws of colloidal chemistry [22-25]. The main problem of such systems is aggregation instability. It explains the aggregation instability of dispersed systems with a sufficiently large and always positive surface seismic energy accumulated on the interphase surfaces of the colloidal chemical system. This surface energy the abundance of iya leads to the reduction of the dispersion of the flow in the system of various processes and, as a result, to the destruction of the dispersed system. The speed and stability of these processes are determined by the nature, phase state and composition of the dispersion medium, as well as the dispersion and concentration of the dispersed phase. The stability of lyophobic dispersion systems can vary widely from almost complete instability to total stability.

From the point of view of physico-chemical mechanics, foam is a two-phase system consisting of gas bubbles dispersed in a liquid. The structure of the foam consists of two layers of surfactant separated by a liquid layer. In this case, the hydrophilic groups of surfactant molecules are directed to the liquid, and the carbon (hydrophobic) groups are directed to the gas phase. The mixture for foam concrete also represents a two-phase "solid-liquid" system.

Particles in the foam-cement system are necessarily brought together, so this system can be conditionally equated to a freely dispersed aggregated system. Over time, it turns into a coherently dispersed system with a solidly dispersed medium cement stone [3].

The quality of foam concrete depends on the dispersion and stability of foams, and they are divided into three types depending on the shape, thickness and other factors of the films: spherical, consisting of spherical bubbles separated by almost liquid thick films; multi-layered and intermediate type - microgas emulsions, the internal phase is formed by the accumulation of gas bubbles [4].

For the preparation of foam concrete, multi-layered foams consisting mainly of a gas phase are used, divided into cells by a thin film. These cells have a polygonal shape and are considered as a system filled with more or less regular polyhedrons. Foams of this type are obtained using aqueous solutions of foaming agents [4].

Analysis of the geometry of polyhedral foams shows the following. If three bubbles merge, the three separating films merge to form a triangular column of liquid, known as the triangular or plateau boundary.

Prior to coalescence, foam films are parallel liquid layers with a Platonic triangle surface, showing a significant pressure drop between the different gas and liquid phases. As a result, capillary pressure occurs and liquid is squeezed out of the film to the plateau boundary, which reduces the thickness of the foam film and reduces its stability. In addition, the decrease in film thickness is due to the flow of liquid from certain upper layers to the lower layers under the influence of gravity.

Three bubbles whose walls are joined at an angle of 120 °C form a mechanically stable system. A fourth bubble can be added to a three-bubble system, but such a system is not stable. When the equilibrium is slightly disturbed, the films move and, as a result, one or more homogeneous hexagonal lattices are formed [4].

The geometry of three-dimensional foams is quite complex. All bubble walls must be the same, because when crossing three walls to form flat or edge boundaries, the intersection angle must be 120°C. The angle of four ribs meeting at one point should be 109° - 28° [5]. Studies of the geometry of real foams carried out at work have shown that such angles are actually observed in foams. The stability of this type of foam depends on the fact that the resultant forces acting on each surface, plateau border or hill are equal to zero or balance with the change in the local pressure of the liquid inside the walls separating the cells. This pressure change plays an important role in the formation mechanism of the foams, as a result of which the films inside the foam become thinner faster than flat films and tear in different places.

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Based on the model of reservation of one air bubble with particles of the solid phase proposed in the analysis of the formation of the structure of foam concrete. Calculations were made based on this model, which showed a clear condition for the ratio of phases f for the formation of a stable foam concrete structure:

(1)

where Vq is the volume of the solid phase of the mixture,

Vs is the volume of the liquid phase of the mixture.

The authors of [8] estimated that the probability of stable presence of newly prepared foam concrete (three-phase) mixture depends on the inter-film fluid Vs consisting of water and foam liquid, the closed solid phase Vq consisting of cement particles and silica filler. they do.

Changing a large number of parameters - scale, pressure, temperature, stability [9] when mixing foam with cement mass using the technology of foam expansion does not guarantee the production of "ultra-thin" foam concrete mixture. This leads to system instability. Therefore, a mixture of closed-cell foam concrete with a regular geometric shape should be obtained.

Ideally, the shape of the pores should be multifaceted, not spherical. This is due to the fact that in the formation of a structure consisting of spheres, there is an uneven distribution of small amounts of cement in the volume of the material with the formation of interconnected pores. The pore structure, which ensures the high strength of the material, along with the smaller thickness, is very useful for the interporous parts.

Conclusion

Heat treatment processes are applied to foam concrete in order to speed up the hardening processes in the traditional way. However, heat-insulating foam concrete with a density of 300-400 kg/m3, exposed to heat from the outside, has a bad effect on the change of material properties due to high temperature. Therefore, the traditional heat treatment process used for heavy concrete was found to be ineffective for light concrete, especially heat-insulating foam concrete. In addition, in the process of heat transfer to foam concrete, the expansion gas can cause the bars between its pores to break. This has a negative effect on its physical and mechanical properties. It is known that chemical additives that accelerate the hardening process have a good effect on the durability of materials with hydration hardening properties, including foam concrete.

The study of foam concrete materials modified with hardening-accelerating additives begins with the process of studying its raw materials. First, the main standard properties of binders, fine fillers, foaming agents and solidification-accelerating additives were studied. The main properties of foaming agents were compared. Normative requirements of additives that accelerate solidification to foam concrete mixtures were studied.

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