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Research Article

THE EFFECT OF ADDITIVES THAT ACCELERATE SOLIDIFICATION ON THE MAIN PROPERTIES OF FOAM CONCRETE: CHANGES IN PHYSICAL AND MECHANICAL PROPERTIES

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Mirzaev Bahodir Kozibaevich
Phd, Associate Professor Of The Department "Manufacture Of Building Materials, Products And Structures", Fergana Polytechnic Institute, Fergana, Uzbekistan

ABSTRACT

At a time when the demand for heat-insulating materials is increasing every year, the production of composite materials with high efficiency based on local and industrial waste can be one of the solutions to this problem. One type of these materials is foam concrete. Use of energy-efficient construction materials, production of wall coverings and heat-insulating products from them. The article considers the issues of improving the main properties of foam concrete under the influence of additives that accelerate the hardening process of foam concrete produced based on local raw materials. The correlation of porosity with mechanical strength was studied. It has been shown that the strength varies significantly when different materials are compressed in a solid fractional volume.

KEYWORDS

Local raw materials, the main properties of foam concrete, composite materials with high efficiency, thermal insulation materials.

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INTRODUCTION

Foam blocks are becoming more and more popular as a reliable and energy-efficient building material 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 several 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, and the building will ultimately be strong and reliable. [1-3].

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 its 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 high-rise buildings.

At a time when the demand for heat-insulating materials is increasing every year, the production of composite materials with high efficiency based on local and industrial waste can be one of the solutions to this problem. One type of these materials is foam concrete.

Literature review

In 2015, researchers from the University of Siegen in the Federal Republic of Germany, such as Reinhard Trettin and Christina Kramer, achieved optimization of the composition of foam concrete through natural additives consisting of proteins and carbohydrates. As a result of this research, concrete suggestions and projects are given to increase the energy efficiency and durability of foam concrete, as well as to reduce its weight [4-7].

Bernd Walk-Lauffer, a senior researcher at the University of Frankfurt, studied the effect of sulfate additives on the main physical and mechanical properties of foam concrete. As a result of scientific research, the total consumption of cement, which is used as the main binding material for the production of foam concrete, has been reduced and the strength index of foam concrete has been increased [8-11].

Researchers have developed a new type of aerated concrete - aerated concrete that can be obtained without an autoclave. The type of binder, sand, the ratio between them, the pore-forming agent, the method of pore formation, the type and amount of chemical additives, the modes of preparation of concrete and the effect on the hardening process have been thoroughly studied. As a result of the research, the technological parameters for obtaining aerated concrete with a density of 500 kg/m3, a strength of 13 MPa and a density of 400 kg/m3, a strength of 9 MPa were developed.

In 1999, the author BSKomissarenko developed the technology of foam concrete with expanded clay without sand. PO-6K was shown as the most effective foaming agent for obtaining this concrete. The average density of developed concretes is 700-900 kg/m3, thermal conductivity is 0.15-0.21 W/m °C and compressive strength is 6.7-8.1 MPa [12-15].

Researcher, researchers Bazhenov PI, Baranov AT, Bryushkov AA, Zavadsky VS, Krivisky M., Kaufman BN, Rosenfeld LM, and many other researchers conducted scientific research on improving the composition of foam concrete. These continue today.

In our country, it is necessary to give special recognition to the research works of EUKasimov, AATulaganov, AASultanov, XXKamilov and others on optimizing the composition of foam concrete based on local materials and studying other aspects of it [15-19].

METHODOLOGY

In the work, the following research comparison, analysis and generalization, observation, measurement, inspection using empirical methods, monitoring and experiment methods were used within the framework of empirical methods-operations.

At the stage of filling the cement system, the formation of the structure is mainly related to the coagulation forces, while the synthesis of the strength of the cement stone is mainly determined by the condensation-crystallization processes. This causes a sharp change in the structural-mechanical and physico-mechanical properties of cement systems: Plasticity and viscosity parameters decrease, and elasticity increases, which is reflected in the ratio of compressive strength and the ratio of bending (compression). In large porous concrete, this ratio is 5-10; when adding active mineral additives, as well as increasing the water-cement ratio and porosity, it decreases by 2-4, which increases the role of coagulation forces in the composition of cement stone. Currently, the following methods are mainly used to increase the strength of cement systems:

- increase in average temperature. Steaming at a temperature of 80-90 °C is often used in domestic enterprises for the production of building materials and products. In industrialized countries such as Europe, America and Asia, steaming is always used at a temperature of 40-45 °C.
- use of plasticizers and superplasticizers. This significantly reduces the water demand of concrete mixtures, which allows for strengthening the strength of materials and the hardness of the hydrated product by 2 times or more.
- in addition to special chemical compounds for binding-hardening accelerators.

Compared to gas-filled systems, these methods have their own characteristics. Let's look at them separately.

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In recent years, the method of accelerating the hardening of cement systems by heat treatment at temperatures up to 90 °C has become economically unprofitable. This is mainly due to the increase in the price of energy fuel.

The effect of temperature on the hardening of foam cement stone can be significantly different from that of heavy concrete. The reason for this is that the increase in temperature has a double effect: on the one hand, the hydration process and structural processes are accelerated, on the other hand, the temperature increase causes gas expansion, which can lead to destructive effects. As the porosity of the material increases, the importance of the second-factor increases. It should be noted that the heat treatment of gas-filled materials that enter the external surfaces of products and structures with heat is not very effective due to the low thermal conductivity of the material.

The simplest and most effective way to increase the strength of traditional heavy concrete is the use of superplasticizers. Unfortunately, the most common internal production superplasticizer C-3, which contains many anionic functional groups - SO3, is not compatible with Penostrom-type foaming agents, as it can cause a decrease in the foam's stability properties.

It is believed that some foaming agents and superplasticizers can be used together. At the same time, the question arises whether it is necessary to reduce the water demand of foam-cement systems, as the average density of products and structures increases. In any case, the addition of superplasticizers to foam concrete leads to 2-3 times more consumption of chemical additives.

Thus, the use of superplasticizers in foam cement materials is problematic and has a relatively narrow field of application.

In recent years, a new class of solidification accelerators, which are mostly organic surfactants containing functional groups such as -SO3, -COOH, -NH2, -NH, etc., has become increasingly common. Usually monomers are low molecular weight substances [20-24]. These additives in the amount of 0.2-0.5% increase the physical and mechanical properties of cement stone by 15-20% at the time of hardening.

This class of additives is undoubtedly of interest as a component of foam-cement systems, for fear of their negative effect on the stability of the foam obtained using the most common anionic foaming agents. there is no reason. Unfortunately, despite the fact that these solidification accelerators are of great practical importance, very little information is provided about them in scientific publications. In most cases, foreign firms use them as part of complex additives, which makes it difficult to assess their role in shaping the properties of advertised building materials and their additives.

It should be noted that these additives are mainly used in heavy concrete technology. We could not find local or foreign publications on the issues of their use in foam concrete. Another class of widely used chemical additives are inorganic electrolytes of CaCh, potassium, sodium nitrite + nitrate, sodium sulfate, etc. and their mixtures

They are effective in concrete work in low-temperature environments even in the negative-temperature environment.

NaCl, $CaCl_2$, $Ca(NO_3)_2$, and $NaNO_3$ electrolytes increase the strength of cement stone not only at room temperature but also during steam treatment [26-31].

However, the strength when compressed is not much at the same time - it increases by 10-20%. The effectiveness of these additives in foam concrete is much lower.

An exception is a mixture of 3% sulfuric acid aluminate and 1% calcium chloride, which increases the strength of the stone at room temperature by 40%. However, such a mixture increases the hardening of cement systems so strongly and dramatically that this additive cannot be called technological.

Many years of experience in the practical use of electrolyte additives show that their effect is very individual and depends on the composition and technology of cement production. In modern technical literature, the influence of new-generation hardening-accelerating additives on foam concrete is practically not considered. The low thermal conductivity of foam concrete is due to its highly porous structure. The air that fills the pores is in a stagnant state and is a poor conductor of heat and therefore creates a high resistance to heat transfer. The size and nature of the pores in the material (for example, macro- and micro-porous structure) play a decisive role in the formation of its construction-operational properties, in particular, the thermal conductivity complex. This indicator makes it possible to determine the thermal insulation indicators of constructions made of foam concrete, taking into account the accepted values of the operational humidity of the material. It depends on the average density and moisture content of foam concrete.

Shakhova LD and others [32-34] studied the properties of foam concrete, in particular, the type of porous structure, the effect of this material on the value of thermal conductivity, and the effect of certain technological factors.

It is known that when the density of materials decreases, the value of their thermal conductivity coefficient also decreases. However, according to the data obtained, such constancy is not always observed: the heat transfer coefficient of the foam concrete sample with density (Water/Cement = 0.6) is lower than the sample with density p = 170 kg/m^3 (Water/Cement = 0.7).

In atmospheric conditions, carbon dioxide, humidity, wind, repeated wetting and drying, air temperature and many other factors affect building materials. Depending on the application of the structure, the materials can be exposed to many atmospheric factors at the same time. The operation process of foam concrete and other products filled with gas is of great practical interest [29-33].

The frost resistance of materials depends on the structure, amount and type of materials, the temperature for freezing and thawing of the material and other factors. Although the material has relatively low strength, there are cases where it is sufficient to resist the cold. In some cases, strong, materials that differ in mass density and porosity are equally resistant to cold. This situation depends on the structure of the material and the structure of the spaces inside it.

The durability of foam and gas concrete in atmospheric conditions depends on the composition and components of the material. When exposed to carbon dioxide in the air, aerated concrete is carbonized, and instead of hydro silicates, calcium hydroxide, calcium carbonate and silicic acid gels are formed. The slowing down of the carbonization process is due to its penetration into the depth of the concrete product. Alternate wetting and drying effects depend on the degree of crystallization of cementitious substances in porous concrete. A lower level of crystallization reduces the strength of concrete [31-36].

Under normal atmospheric conditions, the properties of the solid structure of silicate concrete almost do not deteriorate, but due to repeated wetting and drying processes, they deteriorate in concrete with a multi-cellular structure, therefore, measures must be taken to protect it from these effects.

External structures of various types of aerated concrete (mainly external wall panels) are affected by environmental factors during operation. The effects of water vapour, water, temperature changes, heat and mass transfer processes of chemicals (carbon dioxide, ammonia, etc.) and material changes lead to an increase in stresses in the substance. As a result of these destructive processes, residual deformations accumulate in the materials, cracks appear and open, and in the final analysis, deterioration of its construction and technical characteristics and a reduction in the life of the building structure are observed. Under the influence of aggressive factors of the operating environment, the pore structure of the material changes. By changing the porous structure of concrete and its phase composition, it is possible to prevent the development of possible harmful processes in cellular concrete during the production of products from it.

Uncovering the mechanism of ageing, and analyzing the changes in properties during ageing is of great practical importance. The ageing process can continue with the accumulation of damage in the material, failing building structures, their reliability decreases, and the probability of reaching the limit state increases [34-36]. The practice of using materials prepared in the autoclave process shows that under certain conditions, the effect of the ageing process related to the deterioration of their functional properties is very large, and their material damage during the operation process is very large [32-36].

The effect of repeated wetting and building depends on the degree of crystallization of cementitious substances of silicate concretes. A low degree of crystallization reduces the strength of concrete, so concretes produced without the autoclave process, including foam concrete, are

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less resistant to repeated moisture-building conditions.

The cold resistance of aerated concrete depends on the size of its voids and the structure of the material. Cellular silicate concrete can withstand 25-50 cycles of alternating solidification and thawing, as it is prepared on the basis of a mixture of sand with a surface area of 900 cm2/g and a diameter of 1.5 mm. The cold resistance of cellular concrete is greatly influenced by the method of adding quicklime to the mixture. If it is processed in a disintegrator together with other components, the frost resistance of the materials increases.

The presence of potassium hydroaluminate and calcium hydroclimate substances in cementing materials, soil or polyphosphate sand samples increases the material's resistance to cold. As mentioned above, calcium hydroaluminates are a substance that adversely affects autoclaved silicate materials compared to calcium hydro silicates. Other indicators being equal, the higher the strength of cementitious materials, the greater the frost resistance of the products.

Volumetric water absorption is one of the main indicators of the quality of the cellular concrete structure. With the correct choice of cellular structure and water absorption properties, it is possible to produce aerated concrete with almost the same properties based on various raw materials.

CONCLUSION

The difference in the considered composition depends on the difference in the average size of the pores, that is, the smaller the size of the pores, the higher the strength. The strength of the highly porous material does not change significantly. The mechanical properties of low porosity materials can be influenced mainly by the properties of the solid phase. Heat-insulating foam and aerated concretes are distinguished by high porosity, which determines their strength depending on the strength of the solid phase. In this case, increasing the density of the material matrix by reducing the number of capillary pores does not lead to an increase in the strength of the samples, since the overall porosity of the material does not change significantly. The simplest and most effective way to increase the strength of heavy concrete is the use of superplasticizers. But the most common internal production superplasticizer C-3, which contains many anionic functional groups - SO3, is not compatible with Penostrom-type foaming agents, as it can cause a decrease in the foam's stability properties.

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