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USE OF WASTE FROM SILICATE BRICK PRODUCTION TO IMPROVE THE PROPERTIES OF AERATED CONCRETE

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Анотація

Проаналізовано можливості використання швидкогасячого вапна та відходів силікатної цегли як комплексну добавку для поліпшення виробництва газобетону, що може призвести до скорочення часу тужавлення цементу, підвищення міцності автоклавного бетону та позитивно сприяти зменшенню екологічного впливу виробництва на навколишнє середовище.

Ключові слова*: автоклавний газобетон; силікатна цегла; кварцовий пісок; промислові відходи; утилізація відходів; комплексна добавка; фізико-механічні властивості.*

Abstracts

Analysis of the possibility of using quicklime and silicate brick waste as a complex additive to improve the production of aerated concrete, which can lead to a reduction in cement setting time, increase the strength of autoclaved concrete and positively contribute to reducing the environmental impact of production on the environment.

Keywords: *autoclaved aerated concrete; silicate brick; quartz sand; industrial waste; waste disposal; complex additive; physical and mechanical properties.*

Introduction

In the production of autoclave-hardened aerated concrete, slow-slaked lime is used. If the production of aerated concrete is established in parallel with the production of silicate bricks, this will make it possible to use quick-slaked lime. In this regard, this work considers the possibility of using quick-slaked lime and waste from the production of silicate bricks as additives to the aerated concrete mixture. The significant quartz content (over 75%) in the composition of silicate bricks allows it to be used in ground form as an analogue of ground sand. The work also established a reduction in the setting time of cement and an increase in the strength of autoclave concrete. However, the addition of such additives reduces the mobility of the mixture and increases its water absorption. Deterioration of technological characteristics is observed when ground waste is introduced into the sand slurry of the aerated concrete mixture. Therefore, a complex additive based on silicate brick waste, plasticizer and gypsum stone has been proposed, which allows expanding the scope of application of quicklime, reducing water absorption of the mixture without reducing the mobility of the mixture and increasing the strength of the finished product.

Research results

Autoclaved aerated concrete is one of the leading structural insulation materials used worldwide. Autoclaved aerated concrete is in most cases produced at the same plants as silicate bricks and blocks, paving slabs and dry building mixes [1-2].

A more modern technology for cutting aerated concrete using one edge has waste in the form of a cutting layer, while the production of slaked lime produces unburnt crumb, and the production of silicate bricks produces crumb of this product. The effectiveness of using active mineral additives in the production of autoclaved materials to improve their performance properties [3], reduce energy costs, and the effectiveness of using industrial waste in the production of aerated concrete have been shown by a number of researchers [4].

In my opinion, the most rational option is to use waste and related products of our own production, process them into powders and use them as additives in production [5]. Since the quartz content in the composition of silicate bricks is not less than 75%, it becomes possible to use it in ground form as an analogue of crushed quartz sand [6], and hydrosilicates contribute to increasing strength due to better recrystallization. An example is the use of crushed silicate bricks in the production of lime binder. Since the production of silicate bricks involves grinding lime-silica binder, the issue of disposal is not difficult to solve. The waste remaining from orange bricks is not used as an additive in binding materials in the production of white silicate bricks, although colored bricks are the same ground silica and calcium hydrosilicates. However, in the production of white silicate bricks, it changes their appearance, as well as the appearance of other colored waste, while simultaneously increasing the physical and mechanical properties of the finished product [7].

To date, experimental and practical studies are being conducted [8-9] aimed at creating a complex additive based on silicate brick waste to increase the efficiency of the production of autoclave-hardened aerated concrete on quicklime. For this purpose, a comparison of the grinding ability of silicate brick crumbs and quartz sand was carried out to determine the energy consumption for obtaining powders. The next stage was to study the effect of adding silicate brick powder on the properties of sand slurry and on the setting time of cement used as a structure-forming component during the pre-autoclave hardening period. After that, an assessment of the effect of plasticizing additives and sulfates on the properties of lime was carried out. Then a complex organo-mineral additive was developed. Further, the technological properties of the aerated concrete mixture and the physical and mechanical properties of autoclave-hardened aerated concrete with this additive were investigated.

In the conducted study [10], waste from the production of silicate bricks of the M150 brand in the form of crumbs was considered. These wastes, which are characterized by different grain sizes, were subjected to grinding. At the same time, the grinding of silicate brick crumbs was assessed in comparison with quartz sand to establish comparative energy capacities. The obtained powders were used as an additive to the composition of cement mortars and autoclaved aerated concrete. The physical and mechanical properties of cement mortars and aerated concrete were studied using standard methods according to DSTU-N B V.2.7-308:2015 [11]. The grinding of silicate brick crumbs was assessed in comparison with quartz sand, the results showed that the grinding of quartz sand occurs more slowly than that of silicate brick grains, which indicates lower energy consumption for the grinding process. The effect of adding ground brick on the properties of cement was studied, and it was found that adding up to 10% of ground brick does not affect the setting time of cement. The water absorption of silicate brick powder was 38.8%, and its introduction into the mixture reduces mobility, which can be compensated by prior water absorption. Adding ground brick to sand slurry reduces fluidity, increases water absorption, but reduces density, which helps to increase the heat-shielding properties of aerated concrete [12-13].

To stabilize the viscoplastic properties of the aerated concrete mixture, it is recommended to use plasticizing additives [15-16]. The addition of the superplasticizer naphthalene and dihydrate gypsum slows down the hydration of lime and creates a porous structure of aerated concrete.

The results obtained. indicate the high efficiency of adding the additive in autoclave hardening materials, in particular in aerated concrete on a mixed lime-cement binder. Initial studies of the effect of the additive on the strength of cement-sand mortar confirmed that it is effective under various loading conditions, and in particular where more energy is used.

Autoclaved samples treated with the additive showed higher strength compared to samples after vacuum treatment and those hardened under normal conditions. When adding 5% and 10% of the complex additive to autoclaved samples, an increase in compressive strength was observed by 40% and 64%, respectively. Samples hardened under normal conditions also showed an increase in compressive strength regardless of the composition by 7% for 5% additives and 40% for 10% additives [17-18].

Studies of the properties of aerated concrete grade M150 using injection molding technology and adding the additive in different concentrations showed a plasticizing effect of the developed additive. This led to an improvement in the mobility of the aerated concrete mixture by 8-10% and a decrease in the temperature of the mixture by 5-7°C for every 5% of the additive. The results of testing autoclaved aerated concrete confirmed that the additive improves the physical and mechanical properties of the material, increasing the compressive strength from 16% to 37%. From the considered properties of aerated concrete, it was calculated that the addition of the additive affects the physical and mechanical properties of the product and increases the strength by 15-33%.

Conclusion

Based on the conducted research, it was found that the use of silicate brick production waste to create a complex additive is an effective way to improve the properties of autoclaved aerated concrete. An additive based on these wastes increases the compressive strength of aerated concrete and improves its mobility. It was also found that the use of such an additive can reduce the temperature of the mixture during the production of aerated concrete. The results of the research show that the addition of silicate brick waste to the aerated concrete mixture can improve the physical and mechanical properties of the finished material.

Thus, the use of silicate brick production waste as a complex additive for autoclaved aerated concrete is a promising direction for improving the quality and efficiency of building materials. Further research and implementation of this technology can have a significant impact on the development of the construction industry and contribute to reducing the environmental impact of production.

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