# OBTAINING AUTOCLAVED AERATED CONCRETE USING WASTE GLASS

***CHULKIN N.N.***

*Master's student,*

*Izhevsk State Technical University*
*M.T. Kalashnikov University,*
*Russia, Izhevsk*

***GYRDYMOV D.A.***

*Master's student,*

*Izhevsk State Technical University*
*M.T. Kalashnikov University,*
*Russia, Izhevsk*

***SOKOLOV A.V.***

*Master's student,*

*Izhevsk State Technical University*
*M.T. Kalashnikov University,*
*Russia, Izhevsk*

The purpose of the article is to find solutions for glass waste recycling and improve the construction industry by using glass waste to maintain good product performance. Various types of glass waste in the form of broken glass, spent glass of cathode ray tube (CRT) were used as a replacement for sand in the production of autoclaved aerated concrete (AAC).

**Key words:** mineral binder, cathode ray tube (CRT), broken glass, autoclaved aerated concrete (AAC).

In order to propose a new option for recycling various types of secondary raw materials, research on the production of autoclaved aerated concrete was conducted using cement, sand, quicklime, gypsum, glass waste and modified blast furnace slag. The benefits of implementing effective waste include reducing environmental pollution, reducing disposal costs and landfill volumes, improving recycling technology and economic benefits.

The influence of different concentrations of glass waste on the physical, chemical and mechanical properties of aerated concrete was studied. Cathode ray tube (CRT) glass, broken glass and modified blast furnace slag were used as glass additives.

The main materials used to produce concrete samples were PC 42.5R (rapid hardening) cement, quicklime, quartz sand and gypsum. Various wastes such as CRT glass and broken glass were used as a substitute for sand. The particle size distribution is shown in Figure 1. It can be seen from the figure that cement and lime have

similar particle size distribution.

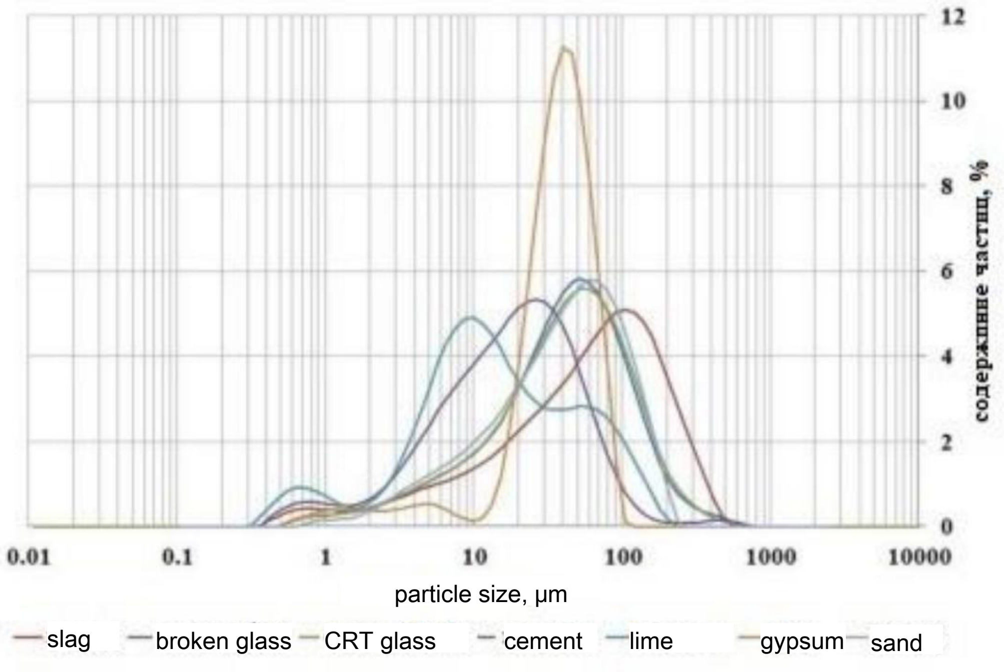


**Fig. 1. Particle size distribution**

Gypsum has the highest content of particles larger than 64 µm. Table 1 shows the different proportions of raw materials with different ratios

Ca/(Si + Al), which were used to prepare the samples.

**Table 1.**

**Composition of samples**

| Experiment | Cement, % | Lime, % | Gypsum, % | Sand, % | Glass CRT, % | Broken glass, % | Blast furnace slag, % |
|---|---|---|---|---|---|---|---|
| 1 | 33.7 | 11.3 | 5.0 | 50.0 | - | - | - |
| 2 | 33.7 | 11.3 | 5.0 | 45.0 | 5.0 | - | - |
| 3 | 33.7 | 11.3 | 5.0 | 40.0 | 10.0 | - | - |
| 4 | 33.7 | 11.3 | 5.0 | 49.0 | - | 1.0 | - |
| 5 | 33.7 | 11.3 | 5.0 | 47.0 | - | 3.0 | - |
| 6 | 33.7 | 11.3 | 5.0 | 45.0 | - | 5.0 | - |
| 7 | 33.7 | 11.3 | 5.0 | 43.0 | - | 7.0 | - |
| 8 | 33.7 | 11.3 | 5.0 | 40.0 | - | 10.0 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | 33.7 | 11.3 | 5.0 | 49.0 | - | - | 1.0 |
| 10 | 33.7 | 11.3 | 5.0 | 47.0 | - | - | 3.0 |
| 11 | 33.7 | 11.3 | 5.0 | 45.0 | - | - | 5.0 |
| 12 | 33.7 | 11.3 | 5.0 | 40.0 | - | - | 10.0 |

The amount of the main raw materials (cement, burnt lime and gypsum) was the same for all the prepared samples. Quartz was replaced by three different types of glass waste at a maximum concentration of 20%. The resulting concrete mixture was poured into moulds measuring 40x40x160 mm. Initially, the samples were kept at atmospheric pressure and a temperature of 60 ºC for 5 hours. After this, the initial process samples were subjected to hydrothermal curing at a temperature of 190 ºC and a steam pressure of 12 bar for 6 hours.

After the autoclave curing process, the samples were dried at 105 °C to constant weight. After cooling, the compressive strength was tested at a temperature of 20 °C using a PGM-100MG4 press. The chemical composition of the samples was determined by X-ray analysis using a Philips PW 1130 and the microstructure using a scanning electron USB microscope AM413ZTDino-LiteProPolarizer.

The results of compressive strength tests of the reference sample and samples with the addition of different types of glass waste are shown in Figure 2.

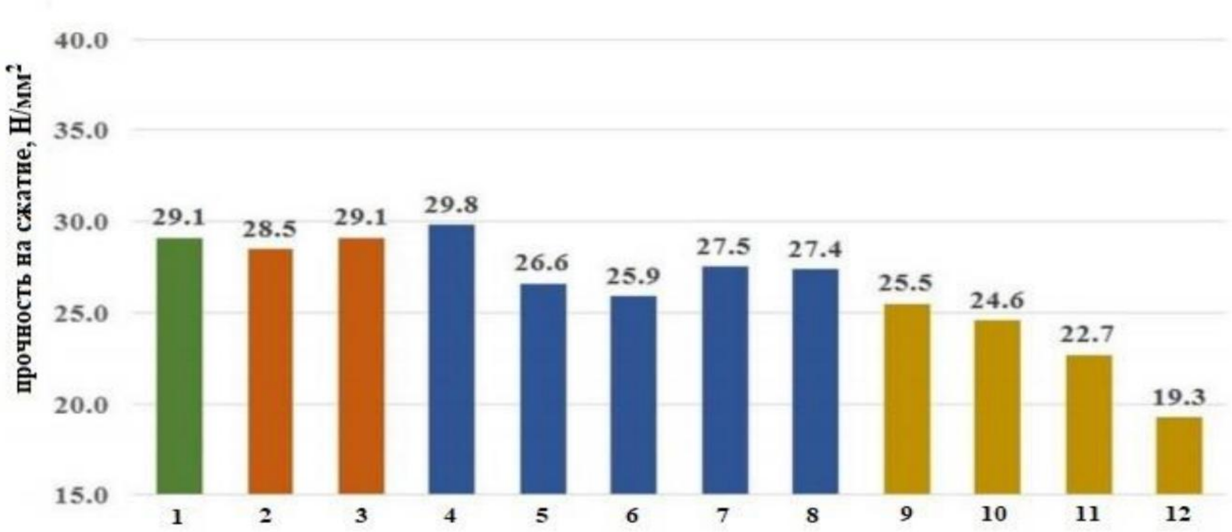


**Fig. 2. Strength characteristics of samples**

The samples with the addition of CRT glass in the initial mixtures have the same compressive strength compared to the reference sample - 29.1 N / mm2 regardless of the cullet content in the mass. Addition of cullet by 1% did not lead to a decrease in the compressive strength of the sample. The greatest decrease in compressive strength was observed for samples with the addition of modified blast-furnace slag. The sample with 20% slag instead of quartz showed that the compressive strength decreases by 33% compared to the control sample. This effect can be caused by a larger grain size of blast-furnace slag compared to CRT glass, cullet and quartz sand. The main hydration products in all samples were tobermorite and CSH phase. Analysis showed that the micropores in the GAT control sample are plate-shaped crystals of tobermorite with a two-chain silicate structure. In addition, in the samples containing different kinds of glass additives, the shape of tobermorite crystals was found to be fibrous. Some well-crystallized C-SH and C SH gel can also be observed on the surface of the glass

grains.

For all samples, X-ray studies confirmed that the main reaction product belongs to the tobermorite group of calcium silicate hydrates (CSH). The reaction sequence is: Ca-rich CS-HoC-S-Ho 11:3 ÿ tobermorite. The reaction product is a mixture of crystalline, semicrystalline and near-amorphous tobermorite, i.e. material with varying degrees of

crystallization.

The same amount of binder was used in all samples. A decrease in compressive strength with increasing additive concentration was observed only for the sample containing blast furnace slag as an additive. This can be explained by the higher content of 64 µm grains (about 50%). KLT and cullet had a particle size distribution lower than that of modified blast furnace slag, so the compressive strength

The compression increases with increasing glass content.

Based on the work carried out here, the following can be made

Conclusions:

- It is possible to produce autoclaved aerated concrete with

adding various types of broken glass;

- compressive strength of autoclaved aerated concrete with glass additives

The CRT and cullet are very similar to the reference sample;

- The pozzolanic properties of glass powder can be the main reason for the increase in compressive strength;
- the inclusion of glass powder does not affect the quality of the hydration products, and no harmful compounds were detected with using X-ray structural analysis;
- The use of glass in the production of GAT can be an effective way of waste disposal.

This article is the result of my research as part of my master's thesis. None of my publications are as important to me as this one. I dedicate it entirely to Natalia.

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