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RESEARCH OF THE PROCESS OF OBTAINING GLASS CONCRETE ON THE BASIS OF WASTE OF THE GLASS INDUSTRY

Abstract: *This article is about the use of waste from the glass industry, glass in the form of cullet, as a filler in the production of concrete. The conducted research allows us to assert that replacing part of the sand with finely dispersed glass is an acceptable way to reduce the use of natural sand, while maintaining the strength properties of the concrete mixture.*

Key words: *concrete, cullet, grinding, fine dispersion, sand, strength, cement.*

Language: *English*

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Introduction

Modern construction is unthinkable without concrete. 2 billion m3 per year - this is the global volume of its use today. This is one of the most massive building materials in many respects determining the level of development of civilization. At the same time, concrete is the most complex artificial composite material that can have completely unique properties. It is used in a wide variety of operating conditions, harmoniously combines with the environment, has a limited raw material base and a relatively low cost.

The last decades of the twentieth century were marked by significant advances in concrete technology. During these years, new effective binders, modifiers for binders and concretes, additional mineral additives and fillers, reinforcing fibers, new technological methods and methods for producing building composites appeared and became widespread.

All this made it possible not only to create and master the production of new types of concrete, but also to significantly expand the range of materials used in construction. Today, over a thousand different types of concrete are used in construction, and the process of creating new concrete is intensively ongoing. Concrete is widely used in residential, industrial, transport, hydraulic engineering, energy and other types of construction.

Concretes are artificial stone materials obtained as a result of solidification of a thoroughly mixed and compacted mixture of a mineral or organic binder with water, fine or coarse aggregates, taken in certain proportions. Before hardening, this mixture is called concrete mixture [1].

In construction, concretes prepared with cements or other inorganic binders are widely used. These concretes are usually mixed with water. Cement and water are the active constituents of concrete; as a result of the reaction between them, a cement stone is formed, which holds the aggregate grains into a single monolith.

2. Experimental

There is usually no chemical interaction between cement and aggregate (with the exception of silicate

concretes obtained by autoclaving), therefore aggregates are often called inert materials. However, they significantly affect the structure and properties of concrete, changing its porosity, hardening time, behavior when exposed to load and the external environment. Aggregates significantly reduce concrete deformations during hardening and thereby ensure the production of large-sized products and structures. Local rocks and industrial wastes (slags, etc.) are mainly used as aggregates. The use of these cheap aggregates reduces the cost of concrete, since aggregates and water make up 85 ... 90%, and cement 10 ... 15% of the mass of concrete. To reduce the density of concrete and improve its thermal properties, artificial and natural porous aggregates are used.

Glass is a valuable secondary raw material, the production of which has already consumed not only natural raw materials, but also significant energy resources.

Recycling broken glass is an urgent scientific and technical task, the successful solution of which can bring significant economic and environmental benefits.

The task is to select the composition of concrete where part of the fine aggregate of natural origin would be replaced by cullet

To obtain concrete, it is necessary to observe the proportionality of the composition to other materials used, such as sand, cement, crushed stone and water. The research used cullet from container crushed glass with a grain size of 0-20 mm. Finely ground glass was used as a filler instead of natural sand, the chemical composition of the glass is given in table 1

Table 1. The chemical composition of container glass

Chemical element	SiO_2	Al_2O_2	Fe_2O_3	CaO	MgO	Na_2O+K_2O	SO_3
Percentage,%	71,5…73,7	0,2…3,3	1,7…3,2	5,2…9,1	0,1…0,6	15,2…16	…0,2

In order to study the possibility of using cullet as aggregates for the manufacture of concrete samples, granite crushed stone of 5-10 mm fraction was used, as a fine aggregate - natural sand and cullet with a grain size of 0-10 mm. The cullet was introduced into the composition of the plastic concrete mixture in the amount of 0, 30, 50, 70 and 100% of the mass of fine aggregate, replacing the sand with the given amount of cullet. Sample sizes, concreting technology, as well as sample processing and the amount of concrete as required by the standard. The composition of the samples is shown in Table 2.

Table 2. The composition of the concrete mix.

Experience number	1	2	3	4	5
The content of cullet from the mass of fine aggregate,%	0	30	50	70	100
Cement, g	150	150	150	150	150
Natural sand, g	205	143	102	61,5	0
Glass break, g	0	61	102	143	205
Crushed stone 5 - 10 mm, g	56	56	56	56	56
Water, g	70	70	69,5	69,5	69,5

Concrete samples made from concrete mixtures of various compositions were kept for 7 and 28 days under normal hardening conditions.

The research results are presented in table. 3.

When compressing concrete, the ultimate strength was determined on cube samples with dimensions of 40x40x40 mm on a YAW-300D (Figure 1)apparatus for building materials. Strength characteristics of concrete samples were determined in accordance with the requirements of standard 10180-2012 “Concrete. Methods for Determining Strength Using Control Samples ”.

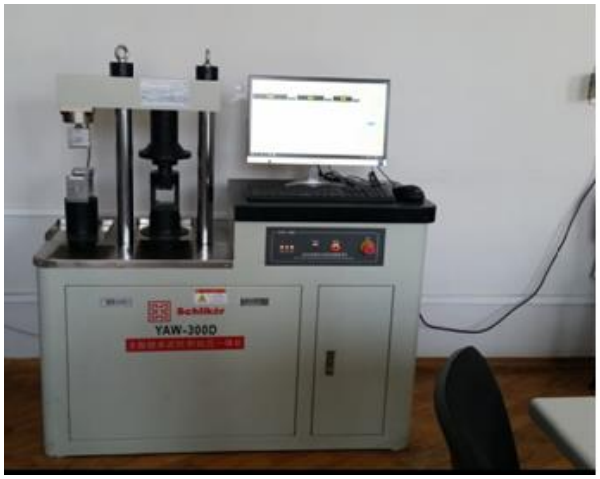

Figure 1. YAW-300D Apparatus

Table 3. Compressive strength (MPa) with the amount of cullet in% of the mass of fine aggregate

Age of samples	The amount of cullet from the mass of fine aggregate				
	0%	30%	50%	70%	100%
7 days	31,4	27,4	30,35	29,7	28,8
28 days	46,5	42,4	42,2	43,2	43, 2

2.1. Rheological results

Studies have shown that replacing fine sand with cullet in the amount of 30% decreases the strength of concrete at the age of 28 days by ≈ 9.2%, and with a further increase in the proportion of cullet in fine aggregate, a slight increase in concrete strength occurs. When replacing fine sand with cullet in the amount of 70%, the strength of concrete at the age of 28 days decreases by 7.2%. It can be assumed that the decrease in the strength of concrete when cullet is added to the fine aggregate is due to the fact that the glass grains have a smooth surface, there is no adhesion to the cement stone.

In order to increase the strength of concrete samples, crushed stone with a fraction of 5-10 mm was used as aggregates for samples of series II, and crushed sand from granite and cullet with a grain size of 0-10 mm was used as a fine aggregate. The cullet was introduced into the composition of the plastic concrete mixture in the amount of 0, 30, 50, 70 and 100% of the mass of fine aggregate, replacing the sand with the given amount of cullet. The composition of the concrete mix is shown in Table 4.

Table 4. Concrete mix comp

Experience number	1	2	3	4	5	6
The content of cullet from the mass of fine aggregate,%	0	15	30	50	70	100
Cement, g	150	150	150	150	150	150
Crushed sand from granite, g	214	182	150	107	64	0
Glass break, g	0	33	64	107	150	161
Crushed stone 5 - 10 mm, g	161	161	161	627	161	161
Water, g	75	75	75	75	75	75

Appearance of concrete samples before and after testing compressive strength tests are shown in figure 2.

Figure 2. Appearance of concrete specimens before and after testing compressive strength tests

The results of testing concrete samples at the age of 7, 14 and 28 days after aging under normal hardening conditions are presented in table.5

Table 5. Concrete strength test results

% glass by weight fine aggregate	Compressive strength (MPa) at age, days				
	Crushed granite sand			Natural sand	
	7	14	28	7	28
0	43,6	44,4	46,6	31,4	46,4
15	39,2	46,2	53,1	26,2	43
30	38,1	44,6	52,4	27,4	42,4
50	39,7	45,3	49, 2	30,5	42,2
75	31,9	41	41	29,7	43,2
100	33,6	35,8	41,4	28,8	43,2

3. Conclusions

According to the test results, the strength of concrete samples on crushed granite sand is higher than the strength of samples with a similar percentage of cullet on natural sand.

Table data. 5 show a small (within 10%) strength gain of concrete with 15% cullet content in crushed granite sand. Then an increase in the amount of cullet in the crushed sand gradually leads to a decrease in the strength of concrete. So, replacing crushed sand from granite completely with cullet reduces the strength of concrete by about 11.3% in comparison with the strength of concretes made only on crushed sand

Thus, taking into account the results obtained, it can be concluded that at a late stage of hardening of composite materials, with partial replacement of the fine aggregate with cullet, a very dense and homogeneous structure of contacts is formed. ¬tiny zone. Strength properties on the basis of glass breakage are determined by the content of individual components in the composition.

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