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Increasing the Resistance of Sulfur-Based Concretes to Temperature Effects

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Annotation

The article presents the results of experimental tests on reducing the level of flammability by adding modifiers to sulfur-containing concrete.

Introduction. Year after year, population growth in the world, especially in our country, increases the need for food, energy and natural gas, equipment and technology. This, of course, accelerates the construction of new industrial, energy and gas production enterprises, residential buildings, and requires a large production of building materials.

It is known that in recent years, huge construction and construction work has been carried out in our country. Construction work is underway at a rapid pace in all cities and villages. In particular, the demand for building materials is growing every day, not only in the local but also in the global markets. In accordance with such high domestic demand, the volume of production of building materials in our country has increased significantly in recent years. In addition, in order to further expand the production of building materials and increase the variety of products in this area, a number of decisions and resolutions have been signed. Particular attention was paid to the implementation of large investment projects to create network enterprises for the production of building materials. Production of energy-efficient, import-substituting, cheap building materials based on existing local materials, eliminating problems in the production of building materials, conducting scientific research to improve the properties of materials, attracting new technologies that can be produced in European countries [1].

The rapid growth of construction is leading to an increase in the use of concrete and reinforced concrete products. This requires the production of cement in large quantities. It is known that the process of burning cement clinker requires a large amount of thermal energy, which leads to an increase in the cost of cement. CO_2 gas emissions from combustion cause environmental problems.

In this regard, the study of new types of cement substitutes, less energy-consuming, characterized by durability and strength properties, is one of the most important tasks of science and practice. It is desirable to use sulfur as a binder in the production of building materials.

Disposal of sulfur produced as a result of oil and gas processing in the territory of Uzbekistan is one of the environmental and technical-economic problems. Its volume is increasing year by year and is several million tons. The environment is polluted as a result of the dispersion of dusty particles of sulfur, reaching long distances when there is wind. Production of building materials from such man-made waste allows to prevent two important problems - environmental pollution and to achieve economic efficiency in concrete preparation. According to statistics, the Mubarak gas processing plant produces 3 mln. per year. emits more than tons of sulfur. In the first half of 2021, the combine exported 500,000 tons of sulfur raw materials to 8 countries of the world. It should be noted that the reserves of sulfur raw materials are sufficient for its use in the production of concrete and reinforced concrete products [3].

Certain scientific and practical results have been achieved in our republic on the creation of modified sulfur binders and modified sulfur concrete based on industrial waste, secondary products of the gas and oil processing industry.

Today, in different countries of the world, sulfur-containing concrete mixture is widely used in the production of materials and structures with the following small parts, such as the construction of road surfaces (sulfur asphalt concrete), the production of road surface elements (pavement slabs, side stones, road barriers, etc.), in the elements of buildings exposed to saline environment during operation (foundations, floors, drainage trays, etc.), in engineering structures (sewer pipes, collector rings, sewage treatment plants, dams, etc.) and in structures exposed to radiation rays.

Research methodology. Along with the advantages of sulfur concrete, there are disadvantages that limit their use as structures in buildings to a certain extent, which are their high temperature resistance (this disadvantage remains to this day and is due to the fact that the melting point of sulfur is 120 ^{0}C), low fire resistance and the presence of cracks during operation [1]. In order to expand the fronts of application of sulfur-based materials and increase their resistance to fire conditions, for the first time, B-2 modifiers were synthesized to increase the fire resistance of concrete products based on sulfur-containing binders, and it was achieved that the materials based on it were transferred to the hard-to-burn group.

Results. Physico-mechanical, chemical and thermophysical properties of concretes based on sulfur-containing binders were determined on the basis of current normative documents [2].

Table 1.**Optimal composition of concretes made on the basis of sulfur binder.**

№	Components name	Control sample	Content		
			1	2	3
1	Breakstone	40	38	36	34
2	Sand	30	28	26	24
3	Sulfur	30	30	30	30
4	B-2 modifier, %	-	4	8	12

***Table 2.* Composition of B-2 modifier for sulfur-containing concretes.**

№	Content name	Quantity, %
1	ADj-14 flame retardant oligomer	10
2	Magnesium hydroxide	44
3	Vermiculite	20
4	Microsilica	10
5	Calcium stearate	1,0
6	Ammonium chloride	15

Compression and flexural strength indicators of sulfur-containing concrete prepared on the basis of modifier B-2, which reduces flammability, were observed to decrease by 3-4% compared to the strength of ordinary sulfur-containing concrete due to the addition of the modifier.

The flammability group of sulfur-containing concretes based on modifiers that increase the level of fire resistance of the B-2 brand was determined by the experimental method of the group of non-flammable and combustible solid fashions and materials based on the requirements of GOST (table 3.17). Mass loss of the sample (Δm) is determined by the following formula:

$\Delta_m = ((m_н - m_к) / m_н) \cdot 100$ (1)

Here: $m_н$ - the weight of the sample before the experiment, g;

$m_к$ - the weight of the sample after the experiment, g.

Mass loss of the control sample

$\Delta_m = ((m_н - m_к) / m_н) \cdot 100 = ((594 – 200) / 594) \cdot 100 = 66{,}3\%$

Mass loss in samples based on B-2 modifier

$\Delta_m = ((m_н - m_к) / m_н) \cdot 100 = ((583 – 389) / 583) \cdot 100 = 33\%$

$\Delta_m = ((m_н - m_к) / m_н) \cdot 100 = ((584 – 407) / 584) \cdot 100 = 30\%$

$\Delta_m = ((m_н - m_к) / m_н) \cdot 100 = ((587 – 419) / 587) \cdot 100 = 28\%$

Table 3.

The results of the experimental method of determining the group of hard-to-burn and combustible solid materials of sulfur-containing concrete prepared on the basis of modifier

Sample for experience	Amount of modifier, %	Maximum temperature of combustion products in gaseous state, ^{0}C	Maximum temperature arrival time, sek	Sample weight, gr		Mass loss of the sample, %	Flammability group
				Before experiment	After experiment		
Control sample	-	180	85	594	200	66,3	Ë3
Concrete sample with added modifier	4	200	100	583	389	33	Ë3
	8	210	100	584	407	30	Ë2
	12	215	110	587	419	28	Ë2

Conclusion. As a result of adding a certain amount of B-2 fire resistance modifier to sulfur-containing concrete, it was possible to transfer these concretes from the combustible group to the difficult combustible group.

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