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STRENGTH CHARACTERISTICS OF SULFUR CONCRETE MADE OF VARIOUS COMPOSITIONS

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The article presents the results of an experimental study of the compressive strength properties of the sulfur concrete cube samples, made of various compositions: modified gypsum binders by the complex use of water preparation sludge, dolomite flour and plasticizer. It is shown that the modification of gypsum binders contributes to an increase of their strength characteristics.

Currently, the oil and gas industry, in particular, the extraction, transportation and refining of oil and gas, poses a serious environmental risks. The significance of research of sulfur concrete is determined not only by the properties of the material, but also by the global environmental aspects of utilization of technical sulfur [1]. Refining waste volumes are constantly increasing due to increased oil and gas production.

For many years of research and experimental work, it was found that concrete based on sulfur binder, comparing with Portland cement based concrete, has better physical-mechanical and strength properties. The main drawbacks of sulfur concrete, identified in the early stages of its use, were low resistance to elevated temperatures, the formation of cracks when laying large volumes. With the development of research and manufacturing technology of sulfur concrete, some indicators have been improved. The solution to some problems was the addition of modifying agents to the sulfur binder, as well as the use of various aggregates in the sulfur concrete composition. This led to the improvement of the plastic characteristics of the sulfur binder and made it possible to reduce the number of cracks, thereby increasing the strength of the material. [1]

Sulfur concrete is a stone-like material, which consists of a solid mixture of aggregates and sulfur. The composition of sulfur concrete includes sulfur binder, inert aggregates and fillers. The use of the latter is quite widespread. They use crushed stone, gravel, sand, various slags and other rocks. [2]

The consequence of high strength properties of sulfur concrete is the structure obtained by combining inert aggregates, fillers, sulfur binder and modifier. Without the use of filler, sulfur is a homogeneous structure, and its molecules are close to each other. The introduction of the filler binds sulfur molecules in such a way that the resulting porosity of the material is minimized (Fig. 1).

Figure 1. – The homogeneity of the obtained sample of sulfur concrete

There are different strengths without modifier in the composition of sulfur concrete, sulfur crystallizes, acquiring an amorphous state. Also, the change in its density causes shrinkage deformation due to the occur-

rence of internal stresses causing micro- and macrocracks in the concrete body. With the introduction of the modifier, the sulfur crystal has a constant strength and remains unchanged when exposed to various factors. Depending on the obtaining desired properties of sulfur concrete, a different modifier can be used. [3]

Sulfur filling with finely dispersed materials has a positive effect on its structure, which is reflected in the increase in strength properties. [4, 5] Therefore, to study the strength characteristics of sulfur concrete, samples of various compositions were made, using materials combining in their grain size distribution both fine particles with a particle size of less than 0.08mm and particles of sand fractions with grain size up to 5 mm.

In one of the compositions we used natural crushed stone FR 10-15, river sand FR. to 5mm, fly ash 0.08, modified sulfur. In another composition, fly ash was replaced with dolomite flour [6] of the same fraction. Depending on the number of all components we've received four versions of the samples. An important feature of the preparation of samples from sulfur concrete was the use of materials from the local region, the use of which is the most appropriate for further study and introduction of new composite materials into the construction industry of the Republic of Belarus.

One of the main technological feature of the preparation of sulfur concrete is the heating of all components of the mixture. The first inert filler and filler was heated to 160 ° C. The modified sulfur was heated separately to a temperature of 140 ° C in order to avoid the release of sulfur dioxide. Next, all the components of the mixture were thoroughly mixed in a heated stirrer until a viscous paste (such as "in / liquid") or solid plastic consistency was formed, depending on the composition. Samples were molded in heated form, and a vibrating table was used to compact the mixture. The test result data are shown in table 1.

Table 1. – Compressive strength of sulfur concrete of various compositions

Variants of the composition of sulfur concrete mix	Set time strength, h	Compressive strength, MPa
Sulfur 25% + modifier 7% + crushed stone 30% + sand 20% + dolomite flour 18% (option 1)	3	59,3
Sulfur 25% + modifier 5% + crushed stone 40% + sand 15% + dolomite flour 15% (option 2)		60,7
Sulfur 25% + modifier 7% + crushed stone 30% + sand 20% + fly ash 18% (option 3)		61,0
Sulfur 25% + modifier 5% + crushed stone 40% + sand 15% + fly ash 15% (option 4)		62,5

Sulfur concrete possesses rapid curing, therefore, the obtained samples of cubes with a final size of 100mm were tested after they were completely cooled (3 hours after production) They were tested to failure under uniaxial short-term compression. In the process of testing, the load, applied to the sample, was monitored. The general view of the samples after the tests are presented in Figure 2.

Figure 2. – Type of destruction of prototypes 2 and 4 options of the composition

Currently, there is a selection of compositions, as well as options for the replacement of the filler and aggregate with various wastes. The results show, that, depending on the type of filler and different variations in the mass fraction of the components, the strength of sulfur concrete changes. Also it is necessary to mention, that the strength of all samples, made of obtained sulfur concrete, is not inferior in strength characteristics to samples of traditional concrete, based on Portland cement. Further study of the properties of sulfur concrete will make it possible to judge the advantages and disadvantages of using different types and amounts of sulfur concrete components.

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