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ANALYSIS OF METHODS FOR IMPROVING THE FROST RESISTANCE OF CONCRETE

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The northern regions of Kazakhstan, the Russian Federation, Canada, the state of Alaska (USA) and the countries of the Scandinavian peninsula are located in a temperature zone characterized by an average monthly temperature of January less than -10°C. All residential, industrial and infrastructure facilities made of concrete are exposed to rainfall and varying temperatures, which cause the concrete stone to lose its strength and aesthetic qualities. It follows that to reduce these negative effects, it is necessary to increase the frost resistance of concrete.

In the northern areas of the countries mentioned above, using concrete slabs is widespread. During operation, concrete slabs exposes by temperature, atmospheric, humidity and mechanical influences.

Concrete and reinforced concrete are now the main supporting building materials, therefore, the material damage from repairing or restoring damaged concrete and reinforced concrete structures is also significant. The interaction of concrete with the environment leads to the emergence and development of destructive processes in them, and as a result, to limit the life of buildings and structures.

Great destructions of concretes cause by frost destruction, which is a consequence of insufficient frost resistance.

Frost resistance largely determines the durability of concrete and reinforced concrete structures, and is the cause of their premature destruction. Study and prediction of frost resistance is relevant and necessary.

Frost resistance of concrete, being one of the main factors providing high durability and serviceability of structures, also requires constant study and correction of normative requirements to it.

The destruction of concrete stone during freezing occurs because when water increases in volume during freezing (about 9%), it creates critical destruction in the pores of concrete. If the concrete has not managed to gain critical strength by the time it freezes, the following happens. There are water films around the pores of the coarse aggregate. When water freezes, they expand and "squeeze" the cement dough from the coarse aggregate. As a result, undesirable pores form in the concrete after defrosting the concrete volume, and the cohesion of the concrete body reduces.

The easiest thing to offer in this case is using of antifreeze additives potash (calcium carbonate), sodium nitrite, and chloride salts. But all the above mentioned additives only contribute to reducing the lower temperature threshold of concrete, that is, make possible the winter concreting. But they can have a negative impact on the strength of concrete, its resistance to aggressive environments and human health. In addition, they do not increase the frost resistance of the finished structure [1-2].

Two main methods using to upgrade the frost resistance class. The first method is to reduce the number of pores and their permeability. This achieves through the use of hydrophobic additives, as well as reducing the water-cement ratio (this brings additional costs for the use of plasticizing additives). A simpler method is the use of special air-reflecting additives, so that we get a certain reserve of pores not filled with liquid under normal conditions. There is a hypothesis that the destruction of concrete during freezing is not due to the pressure of ice (because ice is compressible material), but because the ice, expanding, affects the water remaining in the pores, and it, in turn, destroys the body of concrete. And it is in this case that we need this "reserve" of empty pores. When water squeezes out, it simply goes into the empty pores and does not destroy the body of concrete.

The waterproofing device also has a positive effect on frost resistance. It cannot directly affect the frost resistance class, but protects the concrete body from the penetration of water into it. Water-saturated concrete resists the influence of negative temperatures much worse than in a naturally wet state. But if we can cover basement rooms, structures and foundations with smear and roll-up waterproofing practically without any damage in terms of aesthetics, then the structures of facades, and even more so the places most exposed to weathering (window tides, plinths, upper parts of the facade), we cannot cover with classical waterproofing. For this purpose, uses the penetrating waterproofing, impregnating the concrete thickness and filling the pores with insoluble gel [3].

At present believes that the ability of concrete to withstand cycles of alternating freezing and thawing is mainly determined by the structure of its pore space, in particular, the ratio of open (integral) and conditionally closed pores. Essential importance for obtaining durable (highly frost-resistant) concretes is the ability to quickly determine their frost resistance in a short time. The analysis of existing methods for accelerated determination and prediction of frost resistance has shown that most of these methods have significant disadvantages. In particular, they are labor-intensive, require special equipment that is not available in conventional construction laboratories, do not reflect the physical nature of the processes, and the results obtained have a significant discrepancy with the results obtained by testing by direct freezing and thawing (GOST method).

Some believe that following the rules and procedures described above can prevent the destruction of concrete structures. This is not true. Without strict control over the type of cement used, the quality of aggregates and additives cannot get a concrete structure with a high brand name for frost resistance. If the content of three-calcium aluminate (Ca_3Al) exceeds in portland cement, the porosity and setting time of concrete will increase. With poor quality aggregates reduces the strength and frost resistance of concrete. Requires strict adherence to not only technology for the production of concrete mixture but also technology for the construction of concrete structures. In case of insufficient compaction, or improper maintenance of the structure during the period of strength gain, we will not get proper characteristics [4-5].

The practical implementation will be the development of modified fine-grained concrete capable of operating in extreme cold climate conditions, which will make it possible to expand the range of application of concrete structures and increase their service life and reliability in such conditions.

The analysis of the obtained experimental data on compressive strength showed (Fig.1) that the introduction of plasticizing additives leads to an increase in the strength of samples by 18.2 to 24.5 % in relation to the control samples.

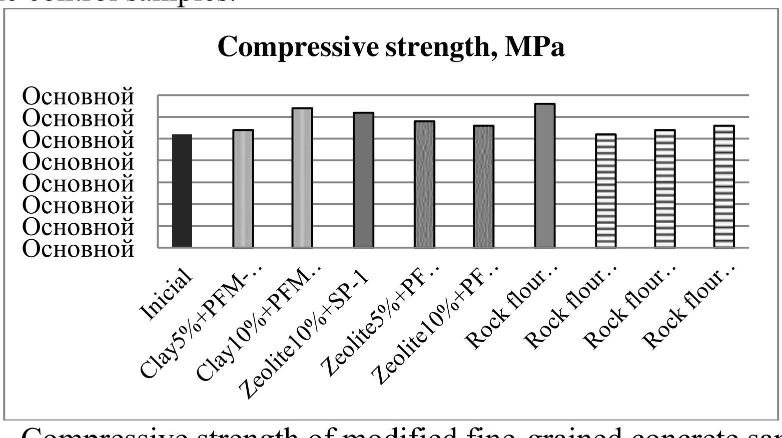

Fig. 1. Compressive strength of modified fine-grained concrete samples

Based on the results of compressive strength, the optimal compositions of samples of modified fine-grained concrete with a composition of hl10%+PFM-NLC, cellulose10%+SP-1 and rock flour 20%+SP-1 were selected, which in the future will be subjected to tests for water absorption and frost resistance.

Increase of durability is caused by directed crystallization of cement stone due to dynamic dispersed reinforcement, mobility control and water reduction of concrete mixture due to modification of fine-grained concrete with plasticizers [6].

Studies of water absorption and frost resistance were conducted according to existing standards "GOST 12730.3-78 - Concretes. Method for determining water absorption" and "GOST 10060.2-95 - Concretes. Accelerated methods for determination of frost resistance at repeated freezing and thawing".

The results of the analysis of water absorption study show (Fig. 2) that the compressive strength of the water is the following of samples after water absorption in the selected samples increases on average by 1.5 times in relation to with the original samples.

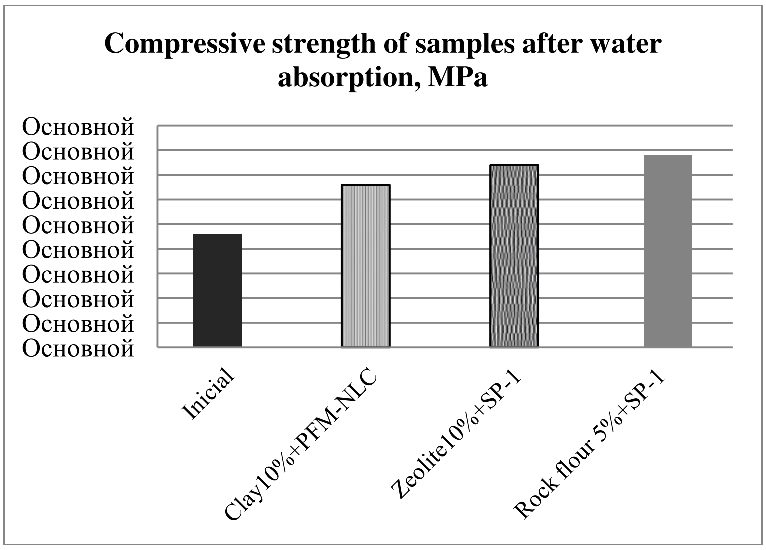

Fig. 2. Compressive strength of modified fine-grained concrete samples after water absorption

This explains by the fact that the hydration process continues in the concrete, the positive effect of compaction of the structure record by colmatation of large pores of salt crystals and hard-to-solve curing products, which leads to a general trend of increasing strength of concrete [7].

Thus, based on the work done, samples of modified fine-grained concrete obtain with a high complex of properties, which can be used in regions with cold climate.

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