Moisture Accumulation and Durability of Panel Walls in Aggressive Environment

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ABSTRACT

The article studies the kinetics of moisture accumulation of saline enclosing structures and studies the effect of volumetric hydrophilization on the salinization process and durability of enclosing structures.

Keywords: Aggressive environment, durability, additives, moisture content, phase composition, concentration, condensate.

The growth of the chemical industry in recent years has forced attention to the humidity regime of enclosing structures exposed to water-soluble salts during operation, which is closely related to their durability, which turned out to be very relevant due to the widespread use of panel walls made of lightweight concrete.

In industrial buildings with aggressive environments, external walls are operated in qualitatively new conditions compared to walls exposed only to gradients of humidity and temperature.

In most chemical plants, the processes of reducing operational properties are complicated by the reactions of the interaction of an aggressive environment with structural materials.

Among the factors determining the durability of concrete structures, the main role is played by the density of concrete and the sign of the miscibility of the surface of the walls of pores and capillaries. Changing the structure of concrete or mortar due to hydrophobization and air involvement increases their resistance to the effects of water-soluble salts.

Numerous works have shown that organosilicon compounds of various types significantly increase the durability of concretes and mortars.

Consequently, the protection of the fence in the conditions under consideration can be solved by volumetric hydrophobization of the material of the insulation layer, which makes up the bulk of the structure.

However, the influence of organosilicon additives on the thermophysical properties and durability of enclosing structures in conditions of salt aggression has not been studied enough. To this end, in the present work, the possibility of using organosilicon compounds such as sodium crystalline ethyl silicate (ESP) and polyphenyl ethoxyloxanes (FES) was investigated.

The study of the kinetics of moisture accumulation in enclosing structures in the presence of water-soluble salts has not been carried out to date. In order to select panel

designs for experimental research, we considered an album of wall panels for buildings with a wet mode and an aggressive environment, developed by TsNIIPromzdany. As a result, a claydite concrete panel with a protective layer of heavy concrete with a thickness of 50 mm was chosen.

The manufactured fragments of panels with a size of 600x600 mm and a total thickness of 300 mm differed from each other in the amount of sodium chloride introduced into the water for creations to create a certain degree of salinity.

Thermophysical studies of the fragments of the panels were carried out using the TBK-2000 thermobaric chamber, converted for the purposes of the experiment. During the experiment, samples of the material were taken to determine the moisture and distribution of salt over the thickness of the panel.

When exposed to an aggressive environment on the enclosing structures during operation, there is a gradual change in the structural and mechanical properties of the material, which depends on the presence and kinetics of two processes: I-penetration of water-soluble salts into the structure; 2-change in the structural properties of the material that directly perceives the influence of the aggressive environment.

In this regard, the next task of this work was to study the durability of enclosing structures operating in aggressive environments.

To study the durability of enclosing structures in aggressive environments, samples of 200x200 mm with a thickness of 300 mm of three types were made: without additives and with the addition of ESNK and PV. The test was carried out in climatic chambers converted for the purposes of the experiment.

On the outer surface side, the fragments of the panels saturated with water and sodium chloride solutions were exposed to a variable temperature sign from -30 ^{0C} (4 hours) to 30 ^{0C} (4 hours).

Determination of the durability of panel fragments after 75 test cycles was carried out on the basis of the following indicators: the state of the textured layer (visual inspection), the change in the compressive strength of the samples. Changes in the strength properties of the tested and control samples were checked using a non-destructive method on the acoustic device UKB-IM.

The average increments of moisture content during the period of moisture accumulation in the panel with a salt concentration of 2.27% by weight is approximately 1.5 times more intense than the humidification of the panel with a salt concentration of 0.39% by weight. This is due to an increase in the dew temperature on the inner surfaces of the panel in the presence of hygroscopic sodium chloride and, approximately, more abundant condensate. At the same time, the drying intensity is about 2 ,5 times less, i.e. the content of sodium chloride in the material of the panel is equal to 2.27% by weight, which corresponds to 17 years of continuous operation, significantly affects the drying processes of the fence structure and is the limit. The panel practically does not dry out in the annual cycle.

When determining the phase composition of the solution, it was found that the concentration of the solution in the textured and structural layers of the panel with a salt concentration of 4.06% by weight during the drying period was greater than the concentration of the saturated sodium chloride solution (saturated solution 35.9 NaCl per 100 g of water). This is apparently due to the evaporation of moisture on the panel.

On the basis of the visual inspection, it was found that the samples with the addition of FES after 75 test cycles retained their original appearance regardless of the concentration of sodium chloride. Samples without additives, aged in a saturated solution, completely lost the textured layer, and in samples with the addition of ESNK, cracks were observed, accompanied by a breakaway of the mortar part of the concrete.

Our experimental studies show that organosilicon additives such as ESNK increase the initial strength of claydite concrete by improving the structure of concrete.

However, the hydrophobic effect of ESNK on sodium chloride solutions (especially saturated) is not enough, which leads to filling

the pores of the material with salt and reducing strength.

At the same time, the hydrophobic effect of FES on water and sodium chloride solutions is so great that the salt content in claydite concrete when soaking samples in a saturated solution even compared to ceramsite concrete with the addition of ESP is about 9 times less.

According to the obtained results of strength studies of samples after 75 cycles, it was determined that at different concentrations of sodium chloride, claydite concretes with the addition of FES and ESNK have strength compared to control samples by 4-8% (FES) and up to 11% (ESNK), respectively. In samples without additives , there is a decrease in strength by 15-18%.

The results of the ultrasound propagation rate confirmed the results of strength studies of the samples.

Based on the study, it was found that the swelling and detachment of the textured layer of the walls will depend on the concentration of the sodium chloride solution and the type of additives. The durability of claydite concrete panels exposed to sodium chloride can be increased by reducing the concentration of salt in the pores, by administering additives.

The results obtained by calculation show that with an increase in the concentration of salts in the layers of the panels, the amount of condensate falling in the thickness of the enclosing structures increases. The difference between the calculated and experimental data is 10-15%. Experimental studies show a higher result.

This should be explained by the greater absorbency of condensate on a vertical surface compared to a horizontal one. Comparing the nature of the change in humidity in the panels of ceramsite concrete, it is necessary to note the following: I - in the absence of salts and at low salt concentrations (0.39% by weight), wall panels dry out in the summer regime; 2 - with an increase in salt concentration of the component, the elasticity of water vapor over the salt spreaders will decrease, which in turn affects the increase in the thickness of the "condensation zone"; 3 - with a sodium chloride content of 4.06% by weight, the precipitation of condensate on the inner surface of the wall panels is 2-3 times greater, compared to panels without salt, in the summer mode the panel does not dry out; 4 - on the basis of experimental and calculated data, the pre-installed The permissible salt content in the layers of wall panels, which is approximately 2.27% by weight, which significantly affect the drying processes.

Experimental studies have established that the most effective measure to protect against salt aggression is the use of an organosilicon additive of the FES TYPE.

Despite the fact that the cost of fences made with the addition of solar power plants is higher than fences without additives, the increase in overhaul terms makes it possible to save about 5,000,000 soums of operating costs per 100 m2 of area.

Of these , the largest share is occupied by savings on capital and current repairs.

It has been established that the introduction of the organosilicon additive FES into the outer textured layer of the panels significantly increases the longevity of the enclosing structures, because it prevents their introduction and penetration of salts into the thickness of the fences.

Based on experimental data, it was established that wall panels with the addition of FES satisfy the operating conditions with salt exposure for at least 25 years.

Based on the technical and economic calculation, it has been determined that justified costs with an increase in the cost of wall panels with organosilicon additives can be 35% of the original cost of unprotected panels.

The increase in the cost of structures with the addition of solar power plants is an average of 4% , but almost per 100 m2 the savings are about 3000,000 soums.

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