Spectrum Journal of Innovation, Reforms and Development
Volume 10, Dec., 2022 | ISSN (E): 2751-1731
Website: www.sjird.journalspark.org

IN AGGRESSIVE ENVIRONMENTS SALT RESISTANCE OF CONCRETE WITH CHEMICAL ADDITIVES

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Abstract
The article presents data from experimental studies of the effect of polymer additives POLY – ANS on capillary absorption of concrete. It is shown that under the influence of POLY– ANS additives, the density, water tightness of concrete increases and hydrophobization of the walls of pores and capillaries is ensured (the wettability of concrete decreases). It was found that for accelerated assessment of the degree of influence of POLY – ANS additives on the permeability of concrete, it is effective to use the criterion of a relative measure of hydrophobicity.

Keywords: capillary absorption, saline solutions, POLY – ANS polymer additive, pore hydrophobization, permeability, criterion of relative measure of hydrophobicity.

The corrosion resistance of concrete is known to be related to the capillary permeability of concrete. In this case, the capillary permeability of concrete depends on the consumption of cement, the parameters of the pore structure, the composition of the salt solution and the test conditions. The degree of influence of chemical additives is determined by the mechanism of their action on the cement system and the pore structure of concrete.

Of the water-soluble polymers, the most relevant in terms of protection against corrosion of crystallization and the impact of a dry hot climate in the republic at the moment are additives of polymer gels. These are additives with a stabilizing effect that reduce the stratification (stratification) of the concrete mix by changing the viscosity of the water. The degree of swelling of hydrogels in water is determined by the density of the polymer network, which is set during the synthesis process.

In the ongoing research, a polymer additive was used - a polymeric reagent POLY-ANS (hydrolyzed stabilizing polyacrylonitrile), manufactured on the basis of waste from the production of nitrone fiber.

Experimental studies have been carried out to establish the effect of the dosage of POLY-ANS additives on capillary absorption [1-12].

Highly concentrated solutions were taken as working salt solutions: 5.5% Na_2SO_4; 2.5% Na_2SO_4 + 5.5% NaCl; 5.5% Na_2SO_4 + 5.5% NaCl, close to natural compositions (mineralized groundwater in the regions of Central Asia and Kazakhstan is characterized mainly by sulfate and chloride aggressiveness with the content of SO2-4 ions ranging from 6000 to 37000 mg/l and Cl from 2000 to 37000 mg/l).The content of additives POLY-ANS is accepted as 0.01 (POLY-ANS 1), respectively; 0.02 (POLY-ANS 2); 0.04% (POLY-ANS 3) by weight of binder and volume of concrete. The capillary absorption of concrete was studied using the developed analytical method for comparative assessment of the degree of influence of chemical additives on the capillary permeability of concrete [1]. The amount of aggressive solution absorbed by the concrete sample for a certain period of time (Wvs , %) is taken as the indicator of capillary absorption.

The criterion for assessing the defectiveness of the structure is the porosity of concrete samples [3-10].

According to the results of the experiments, it was found that the capillary absorption of concrete naturally increases as the composition of the salt solution becomes more complex [12-18]. This can be explained by a higher concentration of ions in sulfate-chloride solutions and a relatively large accumulation of salts in the pores of concrete.

Additives POLY-ANS reduce Wvs to the extent that they affect the reduction of the water demand of the concrete mixture, the parameters of the pore structure and the water resistance of concrete.According to the degree of reduction of Wws of concrete, the additives are arranged in the following descending row: POLY–ANS 3>POLY–ANS2>POLY–ANS 1.

The relative decrease in Wvs concrete in comparison with the standard is 3.1; 1.6 and 1.4 times, respectively. At the same time, the preliminary cyclic temperature effect (taking into account the effect of a dry hot climate) on concrete samples with POLY-ANS additives slightly affects the capillary suction of the salt solution and Wvs changes by 1.09; 1.1 and 1.12 times (Fig. 1).

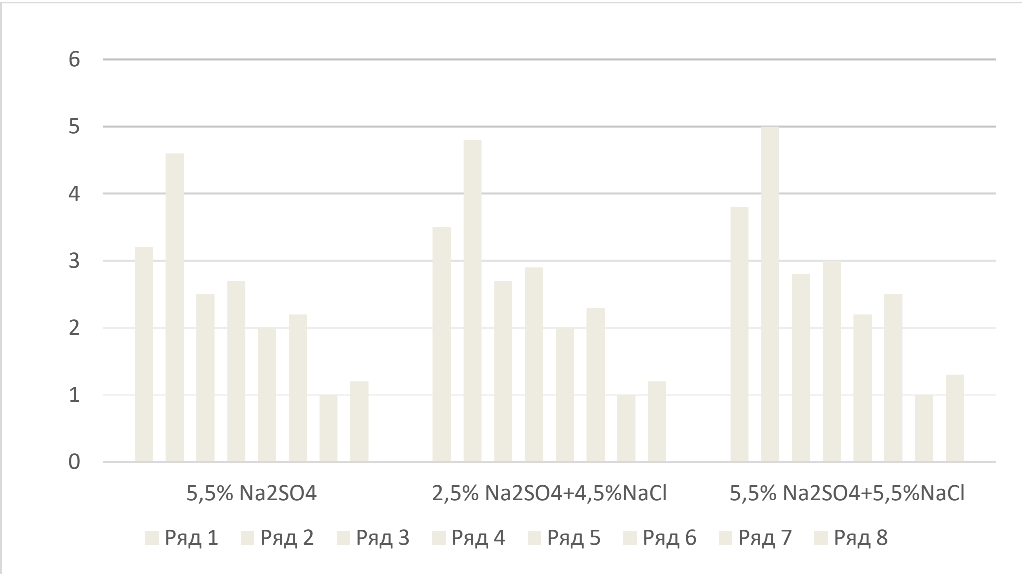

Figure-1. Effect of POLY-ANS additives on capillary suction: 1,2 - reference concrete; 3,4,5,6,7,8 - concrete with additives, respectively POLY-ANS1; POLY-ANS2; POLY-ANS 3; - normal hardening; -after the pre-cycle. temperature effect

The established decrease in Wvs of concrete is due to the fact that under the influence of POLY-ANS additives, the density and water resistance of concrete increase and hydrophobization of the walls of pores and capillaries is provided. Or, in other words, the wettability of concrete decreases. As is known, the measure of wettability (Ms) is the value of cos θ (wetting angle), associated with surface tension at the boundary of three interfaces that are in contact along the wetting perimeter [1-4]:

$$M_c = \cos\theta = \frac{\sigma_{\text{тг}} - \sigma_{\text{тж}}}{\sigma_{\text{жт}}} \quad (1)$$

To assess the hydrophobic properties of the concrete surface, this criterion is not acceptable, since the assessment of hydrophobicity can be made only in limited cases, when :θ>90°.
In addition, the value of the measure of wetting in this case acquires a negative value.
A concept has been introduced - measures of hydrophobicity (Mg) [2-9], which characterizes the hydrophobic properties of the concrete surface and is determined by the formula:

$$\text{Мг} = 1 - \cos\theta \quad \text{или} \quad \text{Мг} = 1 - \frac{\sigma_{\text{тг}} - \sigma_{\text{тж}}}{\sigma_{\text{жт}}} \quad (2)$$

Between the measure of hydrophobicity (Mg) and the measure of wetting (Ms) there is the following relationship:

$$\text{Мг} = 1 - M_c \qquad (3)$$

As applied to concrete surfaces, it is difficult to determine the measure of hydrophobicity according to formula (3), since it is practically impossible to determine its components by known classical methods due to the porous structure of the material[10-20]. Based on this, an analytical method is proposed for calculating the measure of hydrophobicity of concrete by the value of capillary suction, which allows for a comparative assessment of the effect of POLY-ANS additives and other recipe-technological factors on the change in the relative measure of hydrophobicity, taken according to the formula:

$$\text{ОМ}_{\text{г}}^{\text{д}} = 1 - \frac{\cos\theta^{\text{д}}}{\cos\theta^{\circ}} = 1 - \frac{\tan\varphi^{\text{д}} \cdot r^{\circ}}{\tan\varphi \cdot r^{\text{д}}} \qquad (4)$$

Где $\tan\varphi^{\circ}$ - tangent of the slope of the straight line in coordinates $\frac{1}{\text{Н}}$;
$\frac{dH}{d\tau}$ - for concrete without additive;
$\tan\varphi^{\text{д}}$ - the same for concrete with additive;
r° - average radius of concrete capillaries without additives;
$r^{\text{д}}$ - the same, concrete with an additive.

The calculation results are shown in Table 1.

Table 1 Values of the relative measure of hydrophobicity of concrete with additives POLY-ANS when testing samples for capillary absorption of salt solutions

Type of additive	Type of additive			Values of the relative measure of hydrophobicity of concrete with cement consumption, kg/m^3 when tested in salt solutions (numerator - sulfate, denominator - sulfate-chloride		
	290	360	430	290	360	430
Without additive	96,5	92,4	90,8	-	-	-
POLY– ANS1	83,4	80,2	78,6	$\frac{0,46}{0,61}$	$\frac{0,50}{0,62}$	$\frac{0,61}{0,65}$
POLY– ANS2	78,3	76,1	74,2	$\frac{0,60}{0,70}$	$\frac{0,67}{0,73}$	$\frac{0,76}{0,78}$
POLY– ANS3	69,1	66,2	64,0	$\frac{0,82}{0,89}$	$\frac{0,87}{0,90}$	$\frac{0,91}{0,93}$

Conclusions

According to table.1. The $OM_{г}^{д}$ of concrete with POLY-ANS 3 additives naturally increases with an increase in cement consumption and a decrease in the average pore radius.

Thus, for an accelerated assessment of the degree of influence of POLY-ANS additives (and others) on the permeability of concrete, it is effective to use the criterion of the relative measure of hydrophobicity, which makes it possible to solve the problem relatively simply and with high accuracy [14-26].

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