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SOME ISSUES OF MOISTURE TRANSFER IN CONCRETE

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Article history:	**Abstract:**
Received 28th April 2021 **Accepted:** 11th May 2021 **Published:** 7th June 2021	Moisture transfer in concrete is a set of physical processes as a result of which, under certain conditions, prerequisites are created leading, in particular, to the emergence of destructive processes in the composite. Therefore, the study of such complex phenomena, the establishment of the laws of their course is of certain scientific interest. [1].

Keywords: Density, Strength, Crack Resistance, Water Absorption, Water Resistance, Thermal Conductivity, Shrinkage, Moisture transfer, Concrete

Moisture transfer in concrete is a set of physical processes as a result of which, under certain conditions, prerequisites are created leading, in particular, to the emergence of destructive processes in the composite. Therefore, the study of such complex phenomena, the establishment of the laws of their course is of certain scientific interest. [1].

The study of the mechanism of moisture transfer in concrete is inextricably linked with the mandatory study of the pore space of the material, the formation of which proceeded under the influence of a large number of variable factors of a technical and technological nature. The solution of the problems of ensuring the necessary complex of physical and mechanical properties of the designed material (concrete) is impossible without a detailed study of the processes of moisture migration in the pore space of the material being developed, since without taking into account the results obtained, it is not possible to predict the further behavior of the material during operation.

Moisture transfer, especially in concrete under the action of capillary forces, is complex due to the fact that the structure of the pore space of the cement stone is characterized by a wide range of capillary sizes - from $1.5*10^{-8}$ m to tenths of a millimeter [2].

The most important properties of the material, such as density, strength, crack resistance, water absorption, water resistance, thermal conductivity, shrinkage, etc. [3-5].

A.E. Sheikin [6] divided all the pores of the cement stone into three main groups: gel pores, capillary pores and non-capillary pores - transitional.

It has been proven that with an increase in the degree of cement hydration, the total and capillary porosity of concrete decreases, as well as the porosity of the cement gel. The formation of pores in concrete, as shown [7-9], is very effectively controlled in the process of structure formation due to the use of additives of various nature.

Рассмотрим некоторые аспекты формирования порового пространства при отвердевании бетонной смеси и образовании затвердевшего бетона учет которых позволит решать многие задачи при разработке бетонов требуемых показателей свойств.

A.V. Lykov [10] believes that under the influence of temperature, heating on a wet material takes place volumetric evaporation, but to a lesser extent than when a liquid is evaporated from a free surface. This condition is also acceptable for our analysis, since in the process of operation there is an alternating wetting of concrete by atmospheric precipitation.

Water absorption of concrete occurs as a result of condensation of water vapor or water on the surface of the material, the movement of accumulated water through a capillary under the influence of a temperature gradient and internal local stresses in a heterogeneous structure, etc. [11]. Undoubtedly, the course of such processes largely depends on the values of the pore wettability indicators, the degree of their hydration. Thus, an increase in the thickness of the condensate film and a decrease in the drainage rate under the action of gravitational forces will also depend on the roughness of the surface of the solid phase substrate [12]

As you know, moisture filtration through the concrete surface occurs through pores and capillaries. To explain this mechanism of movement of water and water vapor, a classification [13] of pores by size was proposed, according to which the pores of the cement stone are subdivided into contraction - formed during hardening of the "cement-water" system, and the pores formed by the contact of cement stone and aggregate - sedimentation. The pore classification is presented in table. 1.

Macropores of groups 1 and 2 deteriorate the physical and mechanical properties of concrete to the greatest extent. If micropores of groups 3 and 4 are formed during cement hardening as a result of hydration processes, and therefore are inevitable, then pores of groups 1 and partly 2 appear, mainly as a result of imperfect technology (mixing, compaction, hardening conditions) and can change in volume and character in a fairly wide range, depending on the values of temperature, humidity, weather and climatic factors) [14].

Table 1

Classification of pores by groups and sizes

Type of pores	Group of pores and their names	Pore size, micron
Macropores	1 large	$r > 1\text{-}10^{-4}$
	2 capillary	$1 \geq r > 0{,}1$
Micropores	3 transitional (contractional)	$0{,}1 \geq r > 0{,}01$
	4 gel pores	from 5 to 50 Å

When studying the porosity of concrete, it is necessary to establish not only the size of the pores, but also to determine their shape. ON THE. Moshchanskiy and A.S. Berkman, I.G. Melnikov [1, 8, 10, 15] proposed to divide the pores into closed, channel-forming and dead-end (Fig. 1).

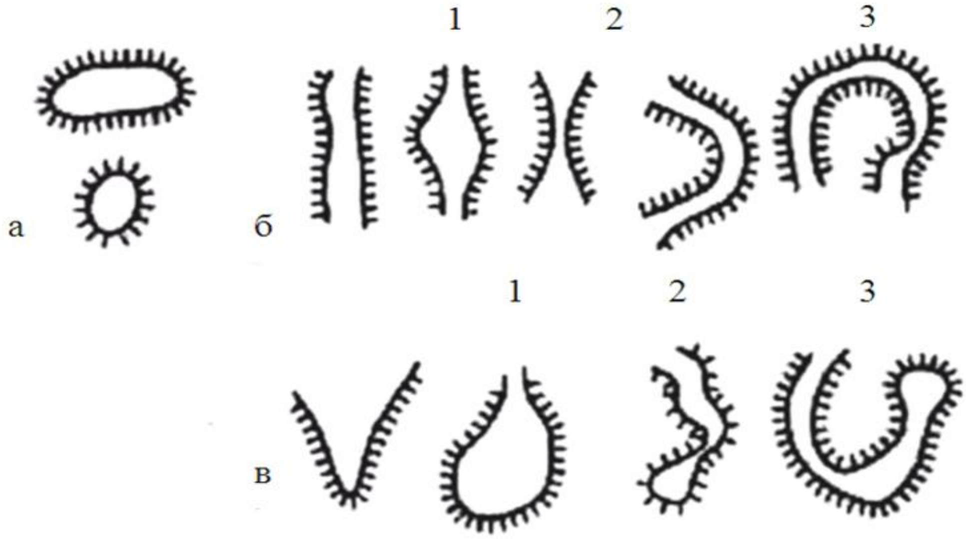

Fig. 1. The main forms of pores (according to AS Berkman and IG Melnikova): a - closed or closed pores; b - open channel-forming pores; c - dead-end pores; 1 - straight lines; 2 - worm-like; 3 - loop-shaped.

The most complete data on the influence of certain categories of pores on the properties of cement stone and concrete are presented in Table. 2 [15, 16].

Table 2

Pore size classification in cement stone

Dimensions	Characteristic	State of water in pores	Properties of cement stone influenced by pore size
1000 - 15 micron	Large spherical voids	Has bulk phase properties	Strength, permeability, frost resistance
15-0,05 micron	Large capillaries	The same	The same
50-10 nm	Medium capillaries. Pores between particles	Moderate surface tension	Strength, permeability, high humidity shrinkage
10 – 2,5 nm	Small (gel) capillaries	Strong surface tension action	Shrinkage
2,5 – 0,5 nm	Micropores, gel pores, pores between crystals	Strongly adsorbed, no menisci are formed	Shrinkage, creep
0,5 nm	Micropores are "interlayer". Pores in crystals	Structural	Shrinkage, creep

The pore structure of concrete is determined by the initial state of the freshly prepared concrete mixture, as well as the composition of the products of cement hydration, their size, and morphology. Of the known factors, the water-cement ratio has the greatest influence on the pore system. The higher this indicator, the greater the value of the integral porosity.

The amount of mixing water depends on the properties of the cement, the fineness of grinding and is determined by the required rheological properties of the concrete mixture. With an increase in W/C, the average size of the formed pores increases, the integral porosity increases, and pore size separation is observed [15, 16].

At W/C>0.38, the products of cement hydration, the gel phase do not fill the pore volume in the hardening cement paste, and therefore there is always some volume of capillary pores, less often in the case of complete hydration of the cement [15, 16].

At W/C>0.7, an interconnected system of capillary pores with macropores is formed in the cement stone [15, 16] and therefore it is impossible to obtain concrete that is durable and resistant in hot dry climates, since the inner surface of the cement stone is accessible for contact with the environment, with the impact and influence of precipitation on it. It should be noted that the volume of micropores is mainly determined by the degree of cement hydration, but does not depend on the amount of mixing water.

The volume of macropores, on the contrary, depends on W / C, since it is directly proportional to the volume of mixing water.

It is the volume of pores, their size and mutual connectivity that determines the permeability of concrete and moisture loss from its surface. In connection with the above, the role of porosity in ensuring the durability of concrete in a dry hot climate typical of Uzbekistan becomes obvious.

The construction practice of modern construction requires the development of rational technological solutions in ensuring the quality of concrete and reinforced concrete, especially at an early age with increased physical and mechanical properties.

In this aspect, in order to achieve this goal, it is necessary to conduct a complex of research to establish the mechanism of moisture movement in the pore space of the material being developed with varying a large number of variable factors of a technical and technological nature.

The data obtained, to a certain extent, make it possible to assess the emerging environment and lead the direction of work on the development of compositions and technologies for creating concretes of the required properties.

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