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Strength Characteristics Of Stress-Cement Concrete (NC) During Heat Treatment In A Bubble-Type Chamber

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Abstract – The article presents research results of the influence of heat treatment modes on strength of concrete on stressing cement.

Keywords – Stressing cement, heat treatment, aerated water, hydro-air circulation chamber, strength of normal hardened concrete.

I. Introduction

Stress cement, being an expanding binder, differs from similar ones in its ability to increase in volume after acquiring strength (8-15 MPa), which ensures adhesion to reinforcement. Thanks to this property, the reinforcement receives tensile stress - concrete - compression, and the reinforced concrete structure becomes self-stressed. In this case, the reinforcement is stretched regardless of the direction of its location in concrete, which makes it possible to create biaxial and volumetric self-stress of structures. Stress cement (NC) is a mechanical mixture of Portland cement clinker (70-80%), an expanding gypsum component (15-20%) and a substance containing active calcium aluminates (10-15%).

The most important indicator of the quality of a self-stressed structure is the strength of concrete during operation. For concretes at NC, it is usually 40–70 MPa. The growth of the strength of the stressing concrete continues intensively after the cement stone reaches the age of 28 days. After 3 months. strength increases by 30%, and after 6 months. - by 40%, which is especially important for hydraulic structures that are loaded a few months after construction.

II. Analysis and Results

The process of heat treatment of reinforced concrete is of key importance from the technological chain of obtaining products of the required quality. Features of the heat treatment of concrete determine not only its strength, water resistance, frost resistance, corrosion resistance, but also the cost of production. Numerous factors also influence the correct choice of the technological mode [1]. Heat treatment can be carried out in the following ways: steaming in chambers, including hydro-aero-circulation (treatment with steam or an air-vapor medium at atmospheric pressure), treatment in autoclaves (treatment with steam at pressures up to 0.8-1.6 MPa), heating in a humidified environment. combustion products of natural and other gases. A common type of heat and moisture treatment (TVO) of concrete and reinforced concrete products is steaming.

The use of renewable energies is an effective way to save fuel in the production of reinforced concrete products. Positive experience has been accumulated in the use of solar energy in the manufacture of precast concrete products in the landfill conditions of precast enterprises located in areas with a hot climate. However, the widespread use of renewable energy sources at the factory was hampered by the lack of fundamentally new technical solutions and the necessary equipment.

Fundamentally new chambers of the "bubble" type have been developed for heat and moisture treatment of reinforced concrete products using a low-temperature coolant of aerated hot water [2]. These chambers make it possible to abandon the construction of boiler houses due to the use of a water heater, as well as renewable energy sources of solar and thermal waters. The possibility of recycling waste water with a high temperature stored in the storage tanks contributes to significant energy savings.

According to [3], "bubble" chambers in comparison with "steaming" ones reduce specific indicators of heat energy consumption by at least 20%, which is 70-80 Mcal / m3. And the fuel economy, depending on the type of renewable backup energy source and the degree of its use, can be in comparison with the standard steam heating from 20 to 70%.

In the studies carried out [4], to identify the features and assess the effectiveness of heating products in the proposed chambers, it was found that:

- the maximum effect of aeration of hot water gives at a rate of rise in the temperature of the medium in the "bubble" chamber 15-40 ° C / h;

- at an average rate of rise of the temperature of the medium of 20 ° C / h, the wetting of the concrete surface by the end of the period of the rise in the temperature of the medium in the "bubble" chamber was approximately 1.8 times higher than in the steaming chamber at the same rate of temperature rise

- for concretes on a number of Portland cements, there is a real possibility of lowering the temperature of isothermal heating in "bubble" chambers to 70 ° C, provided that intensive circulation of the medium in industrial installations is ensured;

- the environment created in these chambers makes it possible to effectively carry out the heat treatment process at precast concrete enterprises, and the design of the chamber provides significant energy savings.

The principle of operation of the "bubble" chamber consists in forced (with the help of pumps) circulation of water from the bath in a closed cycle with the inclusion of a water-air ejector and a heater in this cycle, as a result of which heated aerated water with a high capacity for evaporation and the required temperature characteristics is returned to the chamber. During the circulation of the water-air medium in the chamber, pseudo-boiling is observed on the water surface.

A feature of such a chamber is the inclusion in a closed cycle of air circulation, which is passed through the water by means of a blower (high pressure fan), which makes it possible to significantly increase the degree of evaporation of the vapor-air mixture, turning it into an aerosol.

Comparative tests [7] were carried out for heat treatment of concrete at the NC in two chambers: a hydro-aero-circulation ("bubble") and a laboratory steaming chamber. The purpose of this experiment was to study the kinetics of the increase in the strength of concrete on the NC, subjected to heat treatment in these chambers in various modes. The studies were carried out on heavy concrete. Stressing cement NTs-20 was used as a binder. Quartz sand and crushed granite were used as fillers. The tests were carried out on 10x10x10 cm samples.

From the results of experimental studies given in Table 1 and in Fig. 1, it follows that the strength of concrete on NC exposed to TVO in a hydro-air circulation chamber, at the age of 4 hours after TVO and 3 days, exceeds the strength of similar concrete that has passed TVO in a steaming chamber by 3- four%. On the 28th day. aged strength indicators of concrete subjected to TVO in both chambers are the same.

Table 1. Increase in the strength of concrete that has undergone heat treatment in a steaming and hydro-air circulation chambers, with further hardening in a workshop

Concrete composition C: P: Sch	Steaming mode, hour	Tempe rature, C	Прочность бетона, МПа / % через						Strength of concrete of normal hardening at the age of 28 days, MPa
			4 hours after TVO	3 days	28 days	4 hours after TVO	3 days	28 days	
			Steam chamber			Hydro-aerocirculation chamber			
1: 2, 1: 4, 25 C = 300 kg V / C = 0.62 0K = 2.5 cm	2+3+4+4	80	14,4 46	20,6 66	31,0 100	15,4 50	21,5 69	31,0 100	35,9
	2+3+6+4		16,4 52	21,1 66	31,8 100	17,6 55	22,0 69	32,0 100	36,5
	2+3+8+4		17,1 52	21,5 66	32,8 100	18,6 56	23,0 70	33,0 100	36,8

Note.

1) Environment parameters in the shop: t = 13 ... 17 ° C, φ = 60 ... 80%:

2) Preliminary curing of the samples for 2 hours was carried out in the conditions of the shop.

3) The rate of temperature rise is 20 ° C / h.

An insignificant increase in the strength of concrete at NC, which has undergone heat treatment in a hydro-air circulation chamber, is apparently explained by the lack of moisture removal from concrete. Since during the period of temperature rise, the concrete surface is moistened, which, according to [4], is 1.8 times higher than the moistening of concrete in the steaming chamber. According to [5], the relative humidity of the vapor-air environment in the hydro-air circulation chambers is about 100%, which creates favorable conditions for the structure formation of concrete at the NC. Studies [6] have established that additional moisture of the stressing concrete during the period of temperature rise will contribute to the intensification of the development of self-stress, provided that the concrete structure reaches the required strength.

It can be assumed that the conditions created in the hydro-air circulation chamber may be favorable for improving not only the strength, but also the deformative and other properties of concrete on the NC.

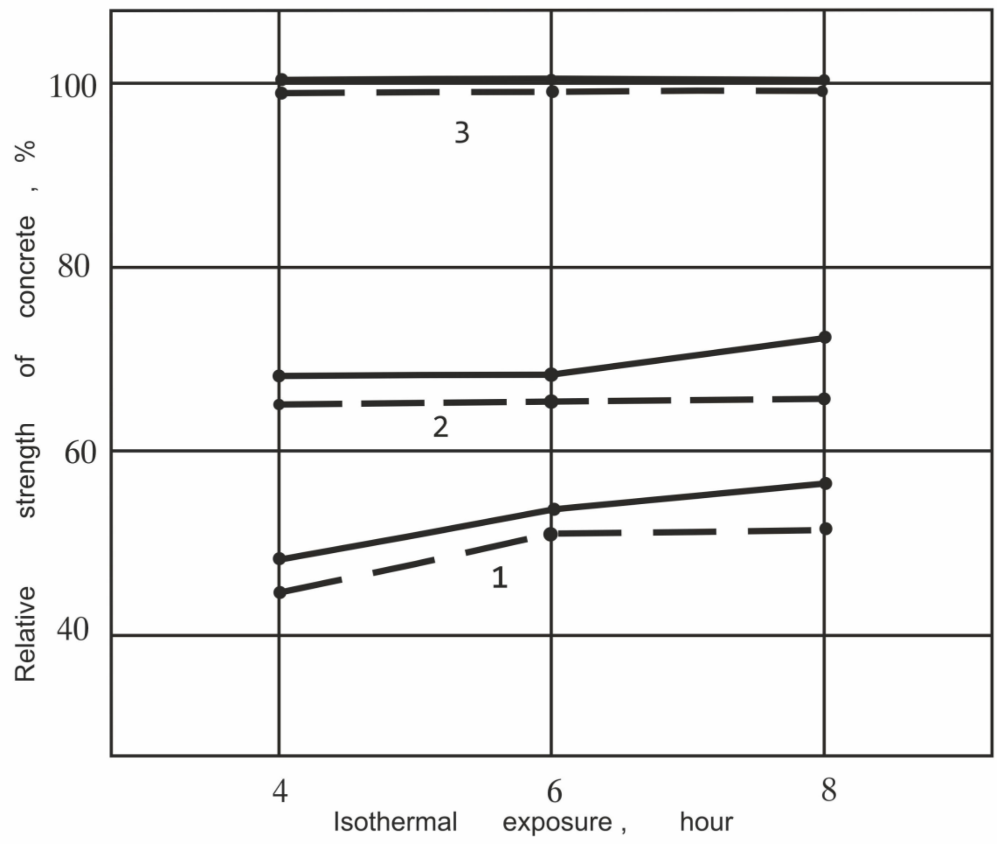

Fig 1. Increase in the strength of concrete on the NC, depending on the conditions of heat treatment.

______________ in the hydro-aero-circulation chamber;

- - - - - - - - - - - - - - - - in the steam chamber;

1- concrete strength after 4 hours of TVO;

2 - the same after 3 days;

3 - the same after 28 days.

It can be seen from Fig. 1 that an increase in the duration of isothermal holding for more than 6 hours does not lead to an increase in the relative strength of concrete on the NC, regardless of the type of chamber.

From Fig. 2 it follows that the greater the strength of concrete after TVO, the more it gains strength in 28 days. age. The strength of normal hardened concrete exceeds the strength of samples that have passed TVO in a hydro-air circulation chamber in 28 days. age by 10-15%, depending on the TVO regimen. A similar picture is observed for concretes at NC, which have undergone heat treatment in conventional steaming chambers (Table 1).

Thus, the heating of concrete in hydro-air circulation chambers not only contributes to a significant reduction in energy consumption in the production of precast concrete, especially in a dry hot climate, but also increases the strength properties of concrete on NC and Portland cements, as shown [4], after TVO they are slightly higher than the strength of concrete , passed TVO in traditional steaming chambers.

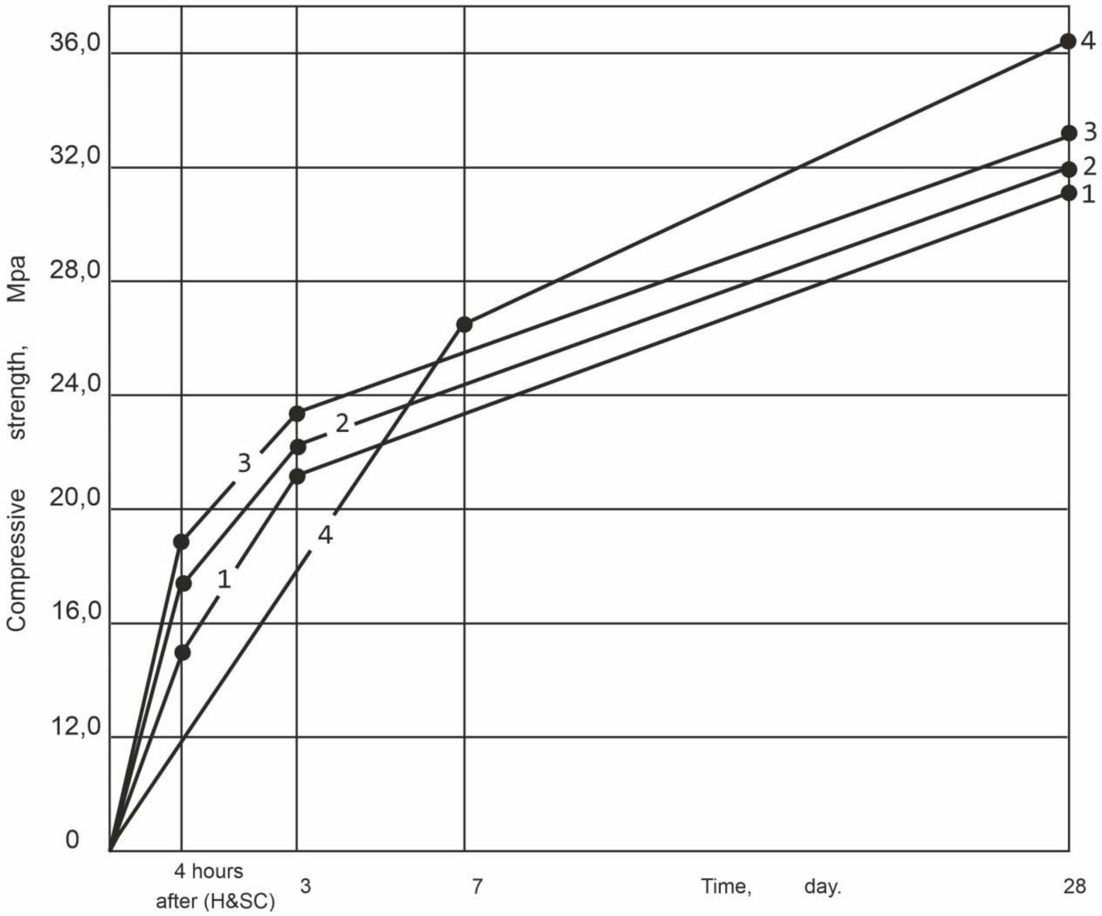

Fig. 2. Increasing the strength of concrete at the NTS Depending on the mode of TVO in the hydro-aero-circulation chamber.

1) 2 + 3 + 4 + 4 hours; 2) 2 + 3 + 6 + 4 hours; 3) 2 + 3 + 8 + 4 hours 4) normal hardening.

If we take into account that the heat release of the stress cement during heat treatment is approximately 2 times higher than the heat release of Portland cement [6], then low-temperature modes of heat treatment (50-70 ° C) of concrete can be very effective in terms of energy consumption and structure formation of concrete. at NC in hydro-aero-circulation chambers.

Replacing the existing pit steam chambers at precast concrete enterprises with hydro-aero-circulating ones makes it possible to abandon steam from boiler units, eliminate the steam supply pipeline system and, at theo same time, reduce energy costs by 25-30% compared to traditional steaming in a dry hot climate.

III. Conclusion/Recommendations

From the above, we can conclude:

- taking into account the ambient temperature when assigning TVO modes to reduce energy consumption in the production of prefabricated reinforced concrete at enterprises in areas with hot climates. At the same time, the negative impact of specific conditions of a dry hot climate on the deformative and other properties of concrete is reduced.

- ironing and temperature conditions created in the hydro-aero-circulation ("bubble") chamber are favorable for the increase in the strength of concrete at the NTS. At the same time, the increase in the strength of concrete on this binder after TVO exceeds by 3-4% the strength of concrete that has passed the TVO in conventional steaming chambers.

- hydro-aero-circulation chambers are an effective type of thermal units for heat treatment of prefabricated products, especially in a dry hot climate, helping to reduce energy costs and creating favorable conditions for the structure formation of concrete.

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