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The Effect Of Hot Climatic Conditions On The Temperature Gradients That Occur During The Heat Treatment Of Concrete

Akmalkhon Mamatxonovich Raximov[1], Damira Gulomjonovna Akramova[2], Irina Yurivna Kovtun[3], Bakhtiyor Maqsud Oglu[4], Aida Zenovevna Maltseva[5]

[1]Associate Professor Namangan Engineering Construction Institute, Namangan, Republic of Uzbekistan

[2]Senior lecturer at the Namangan Engineering Construction Institute, Namangan, Republic of Uzbekistan

[3]Senior lecturer at the Namangan Engineering Construction Institute, Namangan, Republic of Uzbekistan

[4]Senior lecturer at the Namangan Engineering Construction Institute, Namangan, Republic of Uzbekistan

[5]Senior lecturer at the Namangan Engineering Construction Institute, Namangan, Republic of Uzbekistan

Abstract – The article presents the results of the study of temperature gradients that occur during the heat treatment of concrete. Studies show that high ambient temperatures lead to a decrease in temperature gradients during the heating and sale of concrete.

Keywords – Heat Treatment, Temperature Gradient, Cement Exothermia, Temperature Rise, Cooling, Temperature Field, Isothermal Heating, Surface Modulus, Ambient Temperature.

I. INTRODUCTION

As you know, the formation of the structure of concrete during the heat treatment period largely depends on the mode and conditions of heating. The parameters of the heat treatment mode are largely determined by the kinetics of the temperature field over the section of the product. The more uniformly the product is heated, the more uniform strength growth will be ensured throughout the entire volume of concrete, all other things being equal.

The international conference RILEM, held in Moscow in 1964, made a great contribution to the problem. A number of reports were made on the issue of the choice of cement for heat treatment [3, 9] processes of hydration of Portland cement during heat treatment [1,6, 12], reduction of concrete hardening time [2, 5, 10], temperature gradients in concrete subjected to steaming. [4] hardening of concrete in the conditions of Central Asia [11].

The magnitude of the temperature gradient depends on a number of factors: the thickness of the products, the rate of rise in the temperature of the medium in the chamber, the consumption of cement and its exotherm. The influence of these factors is not the

same. The greatest influence on the magnitude of the temperature difference in the concrete of products is exerted by their thickness and the rate of temperature rise in the chamber. Exothermic cement and its consumption in concrete have less impact, especially in thin products.

In the process of heat treatment, large temperature gradients arise during the period of temperature rise and cooling, which can lead to thermal cracking, mainly in products with a thickness of more than 0.4 m. It has.

The increased temperature of the environment in hot climates has a significant effect on the nature of concrete heating and cooling. The nature of the occurrence of temperature gradients changes accordingly.

II. Research Methodology

To clarify the above, experiments were carried out to study temperature fields in the process of steaming and cooling concrete under conditions of elevated ambient temperatures. The experiments were carried out in the summer in industrial conditions on precast concrete hollow-core slabs 0.22 m thick, subjected to heat treatment in pit steaming chambers at the landfill.

The experimental results showed (Fig. 1) that temperature gradients appear during the period of temperature rise and cooling, and their values do not exceed 1 deg / cm. Therefore, the core is heated rather quickly, and in this case its temperature reaches the temperature of the medium in the chamber after 1 h of isothermal holding. This circumstance indicates that for products of small thickness (10-20 cm) 6-hour isothermal exposure is unnecessarily long, especially in hot climates. In this case, it is advisable to reduce it to 3-4 hours, replacing the further keeping of products in the steaming chambers with the lid closed.

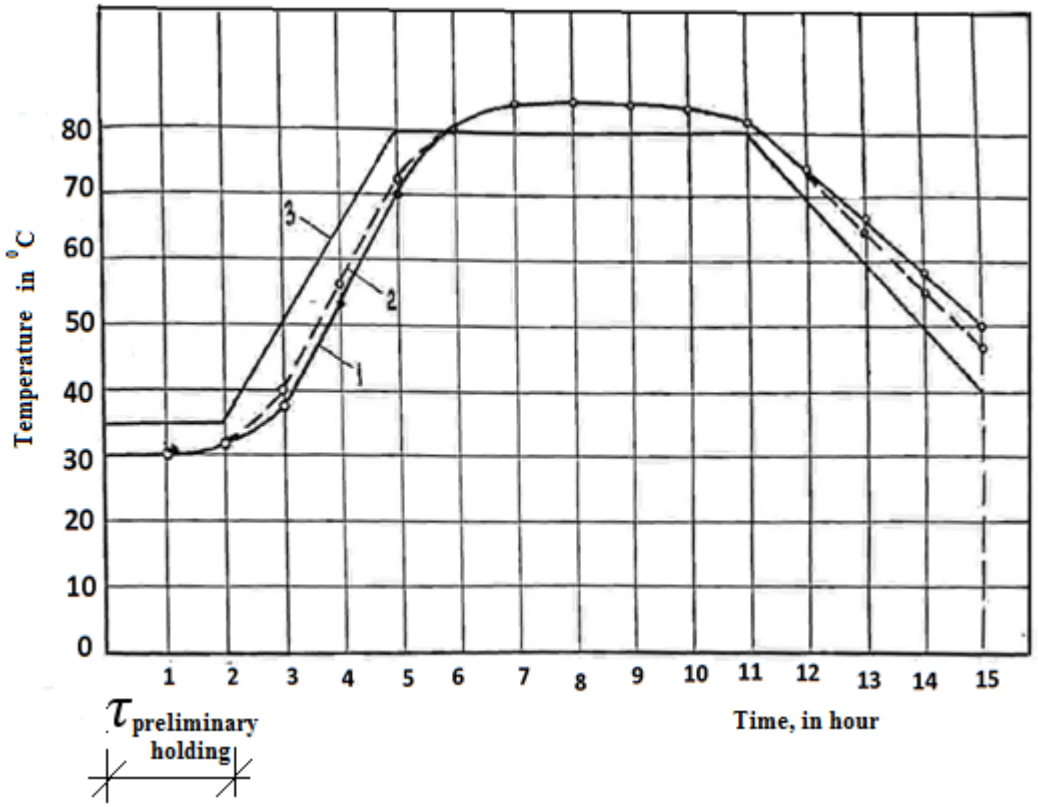

Figure: 1. Change in time of temperature of concrete in samples cubes measuring 10x10x10 cm.

1 - temperature in the center;

2 - the same 2 cm from the concrete surface;

3- temperature of the medium in the chamber and on the concrete surface.

To check the correctness of this proposal, the temperature change in a slab 0.22 m thick made of concrete on Portland cement was investigated. Isothermal heating was 3 hours, then for 5 hours the products were kept in the chamber with the lid closed (Fig. 2).

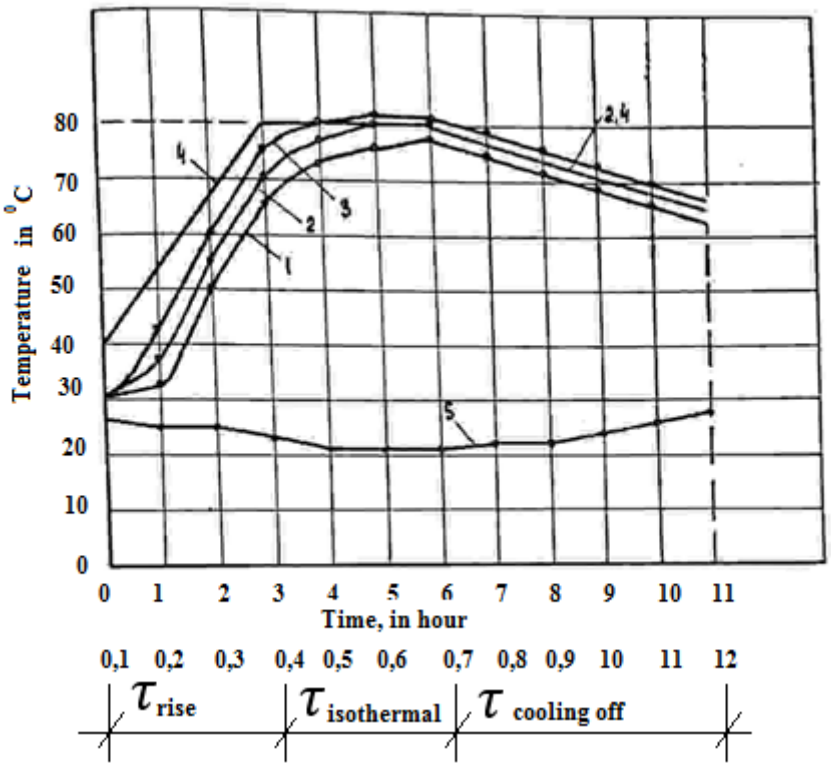

Fig. 2. Temperature change in the center of 0.22 m thick slabs during steaming in a pit chamber.

1, 2, 3 - temperatures, respectively, of the lower, middle and upper row of plates; 4 - temperature of the medium in the chamber and on the concrete surface of the upper product; 5 - outdoor temperature.

$\tau_{под}$, $\tau_{из}$, $\tau_{ост}$ – time, respectively, of temperature rise, isothermal heating and cooling with the lid closed

The largest lag of the temperature in the center of the slab from the surface temperature is 10 °C during the period of temperature rise, respectively, the maximum temperature gradient does not exceed 1 deg / cm. The temperature difference between the bottom and top product is 5 - 10 °C due to the uneven temperature distribution along the height of the chamber. Indicators of concrete strength indicate that this mode (3 + 3 + 5) is sufficient to obtain the required tempering strength of concrete after heat treatment (70% of R_{28}). It should be noted that the spread in strength values between the bottom and top product is up to 5%. The temperature of the concrete in the lower product reaches only 77 °C during the heat and humidity treatment, and the temperature of the concrete in the upper product reaches the temperature of the isothermal holding level (80 °C) within an hour after the end of the rise and as a result, by the end of the heat and humidity treatment, it gains a large amount of degree-hours than the concrete in the underside. This factor is manifested in the difference in the strength characteristics of concrete.

III. Conclusion.

The studies carried out show that the increased ambient temperature contributes to the reduction of temperature gradients in the process of heating and cooling of concrete. An increase in the initial temperature of the concrete mixture in summer conditions has a beneficial effect on the character of concrete heating (Fig. 3). With an increase in the initial temperature of concrete at a constant rate of its rise, the time for heating decreases. With a constant temperature rise time, temperature gradients in concrete are reduced, thereby creating favorable conditions for heat treatment of products with a thickness of more than 0.4 m. The increased temperature

of the environment contributes to the delayed cooling of products after the steam is turned off. In this case, the cooling rate is no more than 3-4 °C / hour.

In summer, after closing the lid, the temperature of the environment in the steam chamber at the landfill is at least 40-45 °C. This creates a real opportunity to raise the temperature in the following order: the product is kept for 1-1.5 hours at a temperature of 40-45 °C, then steam opens and the temperature is raised to the temperature of isothermal heating for 1.5-2 hours. This mode is especially appropriate for heat treatment of massive products (with a surface modulus M_n <10). In this case, not only the steam consumption decreases, but also the temperature gradients arising during the heating of the concrete decrease. And this helps to improve the structure of concrete and the quality of products.

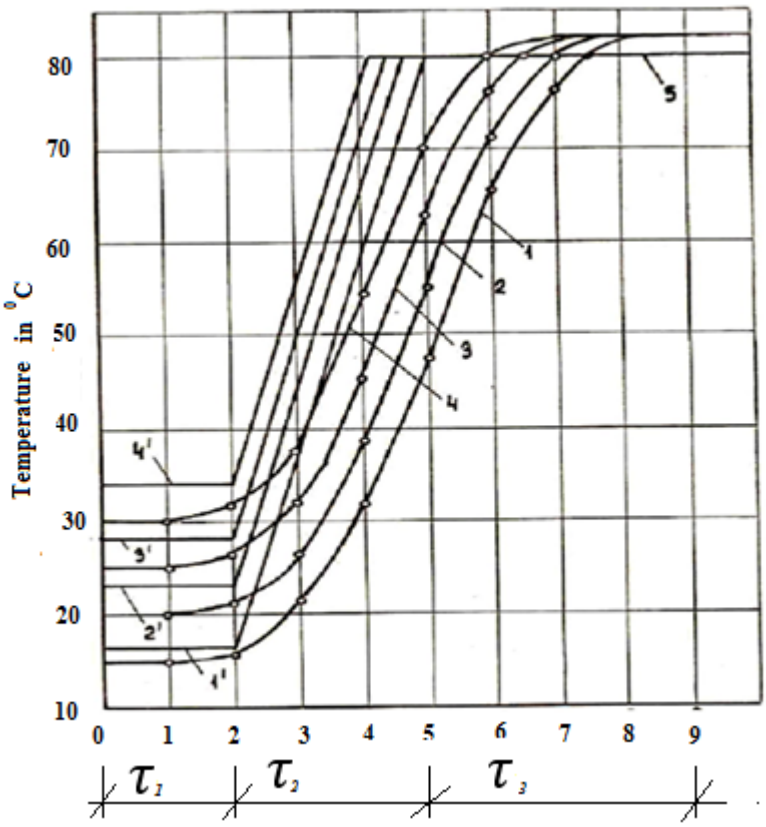

Fig. 3. The nature of concrete heating on Portland cement during heat treatment, depending on the initial temperature of the concrete mixture.

1) concrete with an initial temperature of 15 °C; 2) also 20 °C; 3) also 25 °C; 4) also 30 °C.

1 ', 2', 3 ', 4'corresponding temperatures of the medium; 5 temperature in the chamber;

τ_1, τ_2, τ_3– the time, respectively, of preliminary holding, temperature rise and isothermal heating.

The feasibility of using the heat of the environment in the heat and moisture treatment of concrete for the production of products in areas with hot climates was noted in [7, 8].

Thus, the appointment of the modes of heat treatment of concrete, taking into account the increased external temperature of the environment and the correct organization of work on the molding of products and their heat treatment, can significantly reduce the costs of the heat carrier, increase the turnover of heating units without additional costs at precast concrete enterprises in areas with a hot climate for 6 -7 months a year. Ultimately, the cost of precast concrete products is reduced with the required quality and durability, the productivity of enterprises increases, the free energy source - the heat of the environment - is used to the maximum.

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