RESULTS OF THE ANALYSIS OF LONG-TERM RESEARCH OF TEMPERATURE PERMEABILITY FACTOR OF ENGURI HYDROPOWER PLANT DAM CONCRETE

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Values of temperature permeability factor of Enguri hydropower plant dam concrete included in its technical and operational projects, technical conditions of concrete and cement, technical conditions of concrete work performance at the units, technical project "complex of the activities for regulating temperature conditions of the dam" determined experimentally under lab conditions at hydraulic structure research department and under field conditions at field observations department of Georgian Scientific-Research Institute of Power Engineering and Power Structures, indicated in common normative documents, well-known books of Soviet Union and Georgia, are reviewed.
Comparative analysis showed that all the mentioned data satisfyingly match one another.
Recommendation as to under what limits it is possible to obtain the mentioned thermotechnical property of this structure in provided in the summery.

Key words: ***Temperature permeability factor, in-situ researches, temperature regime, hermotechnical properties, calorimeter method.***

Temperature permeability factor characterizes heat distribution in the structures, constructions, and their heating or cooling velocity and degree. It is considered to be a basic physical (thermo-technical) property of the material. Theoretical and experimental research results of the temperature condition of the structure and constructions significantly depend on the accuracy and reliability of their determination.

According to 1966 technical conditions of the design values and the composition of the concrete of Enguri hydropower plant dam, based on the local experience, 0.004 m^2/hr [1] was taken as a value of its temperature permeability factor. The same value of the mentioned thermotechnical property of this concrete was obtained in 1966 according to the second technical conditions, which was corrected considering the comments of special meeting about the issue of cement and concrete for the technical process of Enguri hydropower plant dam held on 17-20 November, 1966 [2] and according to the technical conditions of the cement and concrete of Enguri hydropower plant dam in 1970 [3], appendix 7^a "activities for regulating temperature conditions of the arch dam" [5] of the book 1 of the unit's technical project "basic structures, arch dam" [4], the technical conditions for carrying out the concrete works at the arch dam in 1971-1972 [6] and "complex activities for regulating heat conditions" of the draft project of the arch dam [7].

Unfortunately, it was impossible to find analogous technical conditions of Enguri hydropower plant dam concrete for the following years.

Based on the normative document BCH-02-64 of Ministry of Power and Electrification of the Soviet Union, the value of the temperature permeability factor of the hydrotechnical concrete was 0.003 m^2/hr.

There was no value of the temperature permeability factor specified in Soviet norms and regulations "construction heat engineering" of 1979 [8] as well as in the norms and regulations "hydraulic river structures" of 1985 [9], and according to the norms and regulations of 1977 "concrete and reinforced concrete constructions of hydraulic structures" [10], norms and regulations of 1987 "concrete and reinforced concrete constructions of hydraulic structures", the value of the mentioned thermotechnical property of the concrete was taken as 0.004 m^2/hr (11 10^{-7} m^2/sec) [11].

In accordance with the normative document "hydraulic structures of concrete and reinforced concrete constructions" developed in Georgia within the following years, 0.004 m^2/hr (10 10^{-7} m^2/sec) can be taken as the concrete temperature permeability value [12].

In accordance with the well-known manual by Academician M. M. Grishin, 0.002-0.004 m^2/hr [13] can be taken as a value for the hydraulic concrete and 0.00275 m2/hr [14] in accordance with the well-known manual by A.V. Likov and 0.00178 m^2/hr [15] in accordance with the well-known book by Academicians M. A. Mikheev and I. M. Mikheeva.

It is known that the value of the temperature permeability factor of the concrete can be determined by the following formula:

$$\alpha = \frac{\lambda}{c \cdot \gamma}, \quad m^2/hr, \tag{1}$$

where λ is the concrete heating permeability (thermal permeability) factor, kcal (m.hr.degree); c – specific heat-capacity of the concrete, kcal (kg.degree); γ - concrete volume weight, kg/m^3 or t/m^3.

However, it can be determined by the direct experiment, by the so called calorimeter method, without using other thermotechnical properties of the concrete like specific heat-capacity and volume weight.

In this case, for identifying the temperature permeability factor of Enguri hydropower plant dam concrete, concrete samples – cubes were used. These cubes were previously used for identifying the values of heat release properties of this concrete, the sample sizes were 49x49x49 cm [16].

Totally three concrete samples with different initial temperatures were tested. Each sample was tested separately.

Each sample was placed in a metal tank filled with water; water was mixed regularly using a special device for establishing almost equal temperature in its entire capacity. The temperature was measured by TCM-XI type electric thermometers, in a central part of the concrete samples and the tank and was duplicated. The thermometer readings were recorded on a special paper tape of MCP-12-08 type automatic self-recording unit.

Each concrete sample was tested in two observation cycles: before placing in the water tank, the temperature in the sample centers made respectively 62^0C, 58^0C and 45^0C. Regular temperature conditions were established in 30-40 minutes and the temperature in the center of the concrete samples before commencing the measurements made respectively $49{,}9^0$C, $49{,}0^0$C and $41{,}5^0$C.

Originally the sample form factor was determined which for cube equals to:

$$S = \frac{h^2}{3 \cdot \pi^2} = \frac{0.49^2}{3 \cdot 3.14^2} = 0.00812 \ m^2. \tag{2}$$

Then, the factor of the concrete temperature permeability was determined. Average arithmetic value as a result of testing three concrete samples made 0.003 m^2/hr. This research was run at Georgian Scientific-Research Institute of Power Engineering and Power Structures, at the department for researching hydraulic structures [16].

The temperature permeability factor of Enguri hydropower plant dam concrete was specified under field observations too, in the structure itself, over 1977-1978. Based on the observations performed in the 18-2 column block between 71.00-71.75 m of Enguri

hydropower plant dam which was concreted in 1975 under the well-known method. An average value of this thermotechnical property of Enguri hydropower plant concrete under the field observations makes 0.00298 m^2/hr [17].

The values of the temperature of Enguri hydropower plant dam concrete stated here are satisfactory and coincide with respective value, 0.003 m^2/hr of the similar composition concrete of Khudoni hydropower plant dam [18].

Summery:

Based of the analysis of the research results, the temperature permeability value of Enguri hydropower plant dam concrete can be taken as 0.003-0.004 m^2/hr. Also, we assume it is better to take its experimental determination result – 0.003 m^2/hr.

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