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Temperature and Moisture-Deformations of High-Temperature-Resistant Concrete Under Single Impact of Water and Temperature

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Abstract: In article results an experimental research of work of the vnetsentrenno-stretched ferro-concrete beams from heavy concrete and from concrete on straining cement are resulted at simultaneous action of longitudinal stretching effort, temperatures and waters.

Keywords: brick, kiln, heat-resistant board, strength, porosity, structure, analysis, coarse aggregate, building structures, experimental research.

Introduction

Large-scale measures are being taken in the Republic of Uzbekistan to introduce energy and resource-saving technologies in the construction industry. In this regard, research on improving the quality and introducing new technologies in the production of building materials is of great importance.

The reliability of structures operating under conditions of temperature and humidity effects, such as storage tanks, hot water storage tanks, trays, channels, significantly depends on the correct consideration of these effects on the properties of concrete and the resulting forces.

In reservoirs, hot water storage tanks, water has a temperature of 90-95°C. The effect of temperature and water affect the nature of the work of a reinforced concrete structure. The transfer of heat and moisture causes the appearance of temperature and humidity gradients along the height of the section. The uneven distribution of temperature and humidity along the height of the section of the elements leads to the formation of temperature-humidity stresses and deformations, the formation and opening of cracks in the reinforced concrete element. Ensuring the durability and operational reliability of reinforced concrete structures can be achieved by studying the operation and developing a calculation and one-sided action of cold and hot water in eccentrically tensioned reinforced concrete elements. For this purpose, an experimental study of the operation of eccentrically tensioned reinforced concrete beams made of heavy concrete and concrete on tension cement was carried out with the simultaneous action of a longitudinal tensile force.

Methods

Experimental studies were carried out on statically defined single-span beams 2.2 m long and statically indeterminate three-span 1.625; +0.75; +1.626 m reinforced concrete beams with a total length of 4.4 m, a section of 15x15 cm from heavy concrete and from concrete at the NC.

The beams were reinforced with symmetrically arranged 4 rods Ø10 mm class A-III with a reinforcement percentage of . Clamps Ø4 mm of class B-I had a pitch of 10 and 15 cm. Deformations of reinforcement and concrete were measured with a dial indicator on bases of 186 and 486 mm. Benchmarks Ø10 mm were welded to the reinforcement and installed in concrete at a section height of 3 cm.

Beams, cubes and prisms were made of heavy concrete with a compressive strength of 56.5 MPa on Portland cement, crushed granite and quartz sand by weight 1: 1.3: 3.2, and self-stressed concrete with a compressive strength of 76.5 MPa on NTs-tensioning cement. 10, crushed granite and quartz sand by weight 1:1.0:1.6. Strength, elasticity modulus, temperature and shrinkage deformations and swelling deformations of concrete were determined on cubes 10x10x10 cm, prisms 10x10x40 cm and 7x7x15 cm, which were concreted from each batch simultaneously with beams. One- and three-span beams were concreted simultaneously from one batch. Vibration was carried out by vibrators to the depth of the laid layer. Before concreting, chromel-copel thermocouples were strengthened in the formwork to measure the concrete temperature along the height of the beam section.

Results and discussion

Heavy concrete samples were kept under normal conditions for 7 days. After stripping, the beams and part of the prisms of the sides were waterproofed with Vilad-17 varnish. The ends of the prisms remained open. Waterproofing was applied with a thickness of 2-2.5 mm in order to create a uniform distribution of moisture across the width of the beams and prisms. Beams, cubes and prisms made of concrete at the NC were stored in humid conditions for 20 hours before stripping. Cubes and prizes made of NTs concrete after stripping, when the concrete acquired a compressive strength of 8-10 MPa, were subjected to water hardening for two weeks, then some of them were waterproofed. The self-stressing energy caused by stressing cement was determined on prisms 5x5x20cm using dynamometric conductors that create elastic resistance to concrete equivalent to the presence of longitudinal reinforcement in it in the amount of 1.0%. The prisms were concreted in a special form directly between the traverses and after 20 hours they were released from the mold and, together with the prism conductor, were placed in a bath with water at 17±2°C. Expansion deformations of concrete from self-stress energy were determined by measuring the traverse deflection deformation indicator until stabilization of concrete expansion deformation within two weeks. Prior to testing, all samples were kept in air-dry shop conditions for 5-6 months. The distribution of concrete moisture along the height of the beam section was determined using concrete prisms waterproofed from the sides with a size of 7x7x15 cm, the height of the prisms was equal to the height of the beams. By weighing, the weight moisture content of concrete in each part of the prism was determined. The established average distribution of moisture along the height of concrete prisms was taken as the distribution of moisture along the height of the section of the experimental beams. To determine the effect of cold and hot water on the compressive strength and tensile strength in a chilled state after exposure to water with a temperature of 50.70 and 95°C, the prisms and cubes were tested on a press. Compared to normal curing conditions, heavy concrete and cold water NC concrete reduce on average 5% cube strength, 3% prismatic strength, 5% tensile splitting strength, and 6% modulus of elasticity. Hot water at a temperature of 95°C reduced on average the cubic strength by 32%, the prism strength by 35%, the tensile strength by 30% and the modulus of elasticity by 38%. For both heavy concrete and NC concrete, exposure to 95°C water increased the reduction in average compressive strength by 7%, tensile strength by 4%, and modulus of elasticity by 9% compared to exposure to 95°C. The influence of hot water on the change in the strength of heavy concrete and concrete on the NC is proposed to be taken into account by the coefficients of the working conditions of concrete in compression, in tension and the decrease in the concrete's elastic modulus by the coefficient.

When completely immersed in cold water for one day, swelling deformations of 15.5 x 10-5 appeared on the NC in prisms made of heavy concrete and concrete. After 22 days of immersion in water, the swelling deformations slightly increased and amounted to prisms from heavy concrete 18.7 and from concrete on NTs -16.7x10-5, and an increase in the swelling deformations of concrete was noticeable in the first 4-5 days of being in water.

In hot water, temperature expansion deformations and moisture swelling deformations develop in concrete. For one day of immersion in water with a temperature of 60ºC, the temperature-humidity deformations of heavy concrete amounted to 62.8•10-5 and concrete at NTs-64.3•10-5, and for 6 days the temperature-humidity deformations increased to 72 prisms of heavy concrete, 6•10-5 and from concrete on NC up to 80•10-5. After heating the water for an hour to 60ºC, the insulation of the tank surfaces of the prisms made of Vilad-17 lacquer lost its waterproofing properties and did not prevent the penetration of water into concrete.

The impact of water with a temperature of 95ºC caused further development of temperature-humidity deformations and they reached values 105.8•10-5 for heavy concrete prisms and NTs-104.5•10-5 for concrete at a moisture content of concrete of 6.5 and 7.8%. Further exposure for 4 days did not lead to an increase in temperature and humidity deformations of concrete. [1]

Conclusions. Thus, hot water with a temperature of 60-95 ºC causes almost 2.5 times more temperature and humidity deformations in both heavy concrete and concrete on the NC than when exposed to the same air temperature.

The coefficient of linear temperature deformation of drying heavy concrete and concrete at NC for temperatures of 60 and 95 ºC is recommended to be taken $d_{bt} 11{,}6\ 10^{5}\ град^{1}$.

In general, it is recommended that the selected composition of the proposed heat-resistant reinforced concrete slab for brick kilns be also used to cover the walls of thermal units.

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