STUDY OF ATTENUATING CREEP OF HEAVY POLYMER-SHELL-CONCRETE IN RECOMPRESSION LOADS

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Abstract. *Experiments on hardness, creep, dry and water-saturated natural heavy concrete and polymer-shell-concrete were conducted. Creep deformation was estimated in multiple concrete loads the value of which was less than the endurance limit. Experiment results show that use of heavy polymer-shell-concrete in the constructions of submarine hydraulic structures is reasonable and effective.*

Key words: *polymer-shell-concrete, heavy concrete, light concrete, creep, porous filler.*

Possibility of controlling creep deformation of the concrete and other solid materials based on what the way of the creep management such as, for instance, reinforcement, friction, selection of concrete composition, removal of the surface-active-substance from the material by its further isolation, removal of particular amount of water from freshly prepared concrete surface by vacuuming, covering thick porous filler of the light concrete with polymer based on what significantly hard new light concrete having high deformation features – polymer-shell-concrete [1, 2] was prepared, was defined by us.

During experiments conducted during preparing polymer-shell-concrete, it was observed that hardness increases, and concrete deformation ability reduces when covering thick filler of the light concrete by polymer resin. Obviously, this happens at a lower degree than in light concretes, which is easy to understand since, in this case, thick porous filler of the light polymer-shell-concrete is isolated from moist and there is no, or there is insignificant adsorption effect hence reducing the creep deformation in the light concrete itself. However, there arises a question – what happens in heavy concrete when covering its thick filler by polymer? In such case, the contact of this filler with the cement admixture improves significantly due to liquidation of water cumulated in the contacts hence increasing concrete's density and filler's cohesion to the cement admixture. Due to this, obviously, concrete's creep deformation reduces, and the more water in the concrete, the more it reduces. Therefore, we decided to identify quantity values by reducing creep specifications of the heavy polymer-shell-concrete with respectively water-saturated and natural concrete.

Special tests on twelve 10·10·10 cm^3 size polymer-shell-concrete prisms were conducted.

Concrete was prepared on clean dry grit (5-10 mm) and sand delivered from Tsitsamuri quarry which was sieved in a 5 mm mesh sieve.

Composition of heavy polymer-shell-concrete per m^3:

Cement – 300 kg;

Grit – 1100 kg;

Sand – 800 kg;

Water – 120 l;

Epoxide – 20 kg;

Hardening polyethylene-polyamine – 2 kg;

Shrinkage – 3 cm;

Vibration duration – 30 sec.;

400 grade ShlakoPortlandCement from Rustavi Cement Plant was used as a binding material and coverage of the thick filler was done by epoxide resin by polyethylene-polyamine binding material.

The samples to be tested – prisms - were kept under natural environment for 3 hours from their preparation, then they were moved to a steaming chamber at 2+5+2 hrs concrete's thermo-humid regimen at a maximum temperature of 100^0. Concrete moulding was conducted after 14 hour steaming and then they were kept in a mode room under normal natural conditions.

At the age of two months, half of the test samples were placed in water for 10 days, and another half – under natural dry conditions after which they were tested. Three samples from each series were tested on compression breaking load and their average value was: water-saturated polymer-shell-concrete P_{water}=2000 n, and naturally dry - P_{dry}=2050 n.

Three samples from each series were tested on creep at multiple loads 0,5 P_{water}=1000 n. Deformation was measured by two watch-type indicators placed opposite to each other, measurement value – 1 mcm (micrometer) at 100 mm base. The results obtained are given in Fig. 1 and 2. As seen from diagrams, heavy natural and water-saturated polymer-shell-concretes are equally hard during multiple creep loads and creep would attenuate during multiple loads, particularly after 12-16 loading and unloading cycles and, in this case, maximum creep deformation is: ε_{dry} =18·10^{-5} for naturally dry concrete and ε_{water}=15·10^{-5} for water-saturated concrete.

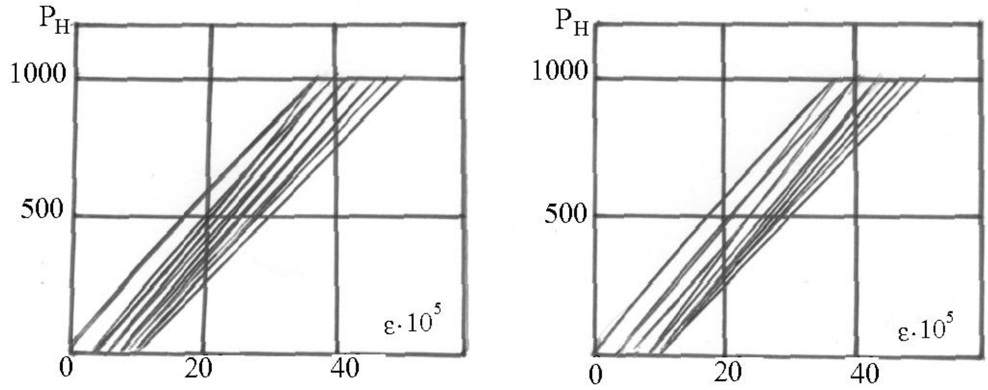

Figure 1. Creep of naturally dry polymer-shell-concrete in multiple loads

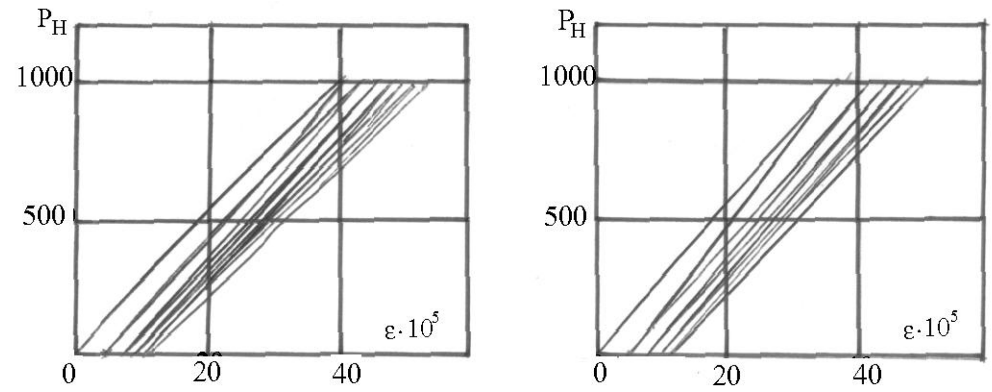

Figure 2. Creep of water-saturated polymer-shell-concrete in multiple loads

As we see, an impact of humidity on the hardness and creep for heavy polymer-shell-concrete is insignificant which is important for the application of polymer-shell-concrete in the constructions of the hydraulic structures.

When researching the attenuating creep of naturally dry and water-saturated heavy concrete in multiple compression loads, twelve 10·10·40 cm^3 size naturally dry and water-saturated prisms were prepared.

Concrete was prepared on 5-20 mm grit and 0,5 mm sand delivered from Tsitsamuri quarry. Rustavi ShlakoPortlandCement was used as binding material.

Composition of concrete per m^3:

Cement – 300 kg;

Grit – 1100 kg;

Sand – 800 kg;

Water – 120 l;

Shrinkage - 3 cm;

Vibration duration – 30 sec.

Concrete was maintained and the samples were tested in the same way as in heavy polymer-shell concrete case. An average compression breaking load of heavy concrete was P_{dry}=1550 n, and water-saturated one - P_{water}=1040 n. Force applied when testing the water-saturated samples at multiple load was 0,5P_{water} =500 n. The same multiple loads was applied to naturally dry concrete samples, as when comparing the creep value of the water-saturated and dry concretes, multiple loads equaling to one another that should be less than their endurance limit, should have had an impact on them. The results are given in Figures 3 and 4.

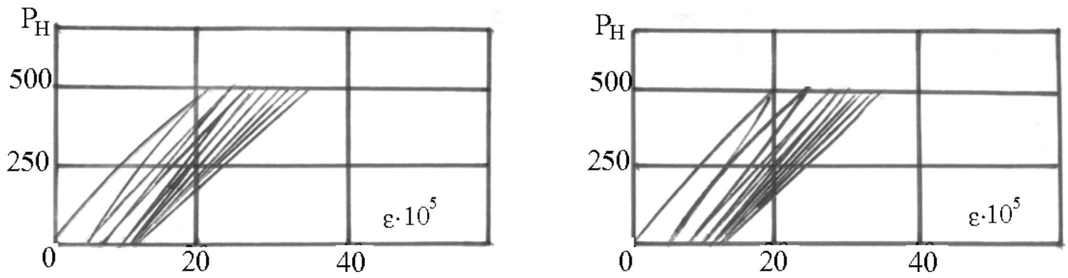

Figure 3. Creep of naturally dry concrete in multiple loads

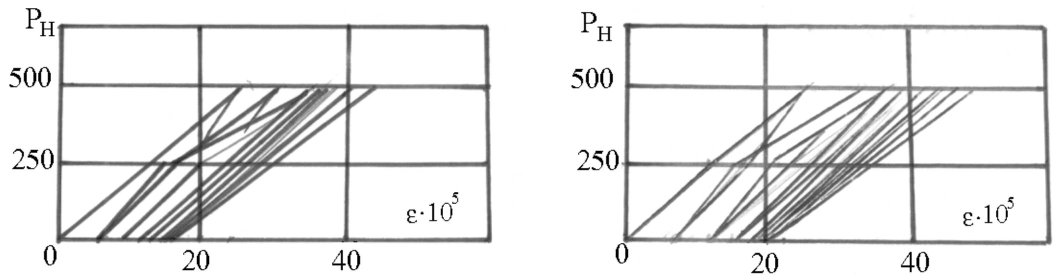

Figure 4. Creep of water-saturated concrete in multiple loads

As seen from the provided diagrams, water saturation significantly reduces the hardness limit and increases the creep deformation of the normal heavy concrete. At the same time the creep deformation of the naturally dry heavy concrete attenuates in multiple loads at n=25-30 loading and unloading cycles and respectively, its relative deformation is ε_{dry} =$18 \cdot 10^{-5}$. The creep of the water-saturated heavy concrete attenuates at n=55-60 loading and unloading cycles and relative deformation of the creep is ε_{dry} =$33 \cdot 10^{-5}$.

Based on the experiment results we can conclude that by replacing the heavy water-saturated concrete by heavy polymer-shell-concrete, its hardness increases significantly, the creep deformation reduces, and such increase is much higher than when replacing the naturally dry heavy concrete by the heavy polymer-shell concrete

Given the above, it is obvious that it is both reasonable and effective to use the heavy polymer-shell-concrete in the constructions of the submarine hydraulic structures.

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