INVESTIGATION OF THE DAMPED CREEP OF CONCRETE IN BENDING USING SPECIAL EQUIPMENT AND TAKING INTO ACCOUNT THE INFLUENCE OF POLARITY OF A SURFACE-ACTIVE SUBSTANCE

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It was show that the creep deformation of pumice concrete with an aggregate saturated with 0.5% $CaCl_2$ solution is an essentially more intensive process than the creep deformation of pumice concrete prepared with a water-saturated aggregate. Hence we conclude that the higher the SAS polarity, the higher its wedging-out action which intensifies the development of creep deformation.

In investigating the creep of concrete we decided to limit our tests to the case of pure bending, in which concrete shrinkage does not influence or influences very insignificantly creep deformation which manifests itself in deflections. It is the well known fact that the plane section hypothesis (Bernoulli hypothesis) is valid also in the case of creep of bendable concrete elements which are subjected to pure bending load. In this case if the constant load does not exceed half the breaking load and the dimensions of beams are small, then the neutral axis will pass approximately in the middle. It is obvious that in this case the shrinkage of the tensioned and compressed parts of beams will be nearly identical and will not cause deflection. Therefore deflection will occur (under constant load) mainly due to creep.

As is known, all strength and deformation peculiar properties of light-weight concrete, which are produced by a strong adsorptive influence of water, consist in its wedging-out action in micro cracks of a stressed light-weight aggregate [1, 2].

As is known, hydrophilic materials such as concrete, stone, gypsum, wood, glass, mica and so on are not apt to creep, while in the wet state (the more so in water) they become creepy.

In order to establish an extent of the influence of the wedging-out action of a surface-active substance (SAS) in micro cracks of concrete on its creeping property depending on the SAS polarity, we carried out special bending-tests of the experimental concrete specimens. The specimens were made of concrete with a water-saturated porous aggregate in one case and with an aggregate saturated with 0.5% calcium chlorine ($CaCl_2$) solution having a greater polarity than water in the other case.

In the latter case we expected to have a greater wedging-out action that would inevitably lead to the growth of creep.

For our tests we used 5×8×60 cm beams made from pumice concrete. Concrete was prepared using anian pumice materials: crushed stone of 10-20 mm in size and sand sieved through a 5 mm mesh-screen.

As a binding agent we used Portland slag cement of brand 400 of Rustavi cement plant.

The composition of pumice cement, kg, per 1 m^3, was as follows: cement – 400, crushed stone – 500, sand – 400, water 180 l.

The quantity of experimental 5×8×60 cm beam-specimens was 12, of which 6 pieces were manufactured from pumice concrete, while the other 6 pieces were prepared with aggregates saturated with a 0.5% $CaCl_2$ solution.

All experimental beams were prepared in metal moulds on the laboratory vibration table, thevibration duration was 30 seconds. They were removed from the moulds 48 h after preparation and left to age up to two months in a chamber with normal storage conditions (relative humidity – 70%, temperature - 20^0C).

At the age of two months the beams were tested for creep in bending. Tests were run using special equipment (Fig. 1) consisting of rigid base 1, in the spatial grooves of which steel cylinders 2 were installed. The cylinders served as supports for specimen 3. Placed on the specimen was the loading device consisting of two rods 4 connected with each other by lateral cheeks 5. The ends of pin 6 carried clevises 7 connected with each by cross-arm 8 used for suspending the load. The loading device was a spatial hinged system that provided a strictly identical loading uniformly distributed throughout the specimen width and applied to the specimen at two sites.

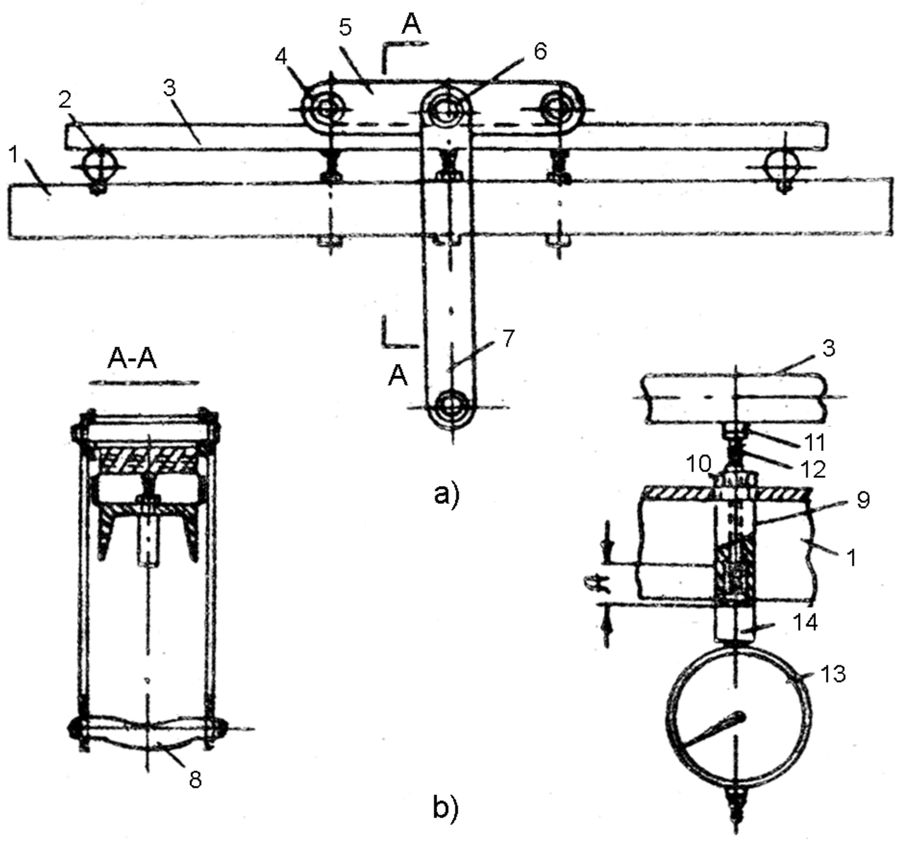

Fig. 1.

To measure deformation, special devices were mounted on base 1, which consisted of cup 9 (fastened by nut 10), through the opening of which passed measuring pin 11 pressed against the specimen by means of spring 12.

Deformation was measured (Fig. 1,b) by indicator-comparator 13 equipped with special tip 14 that provided its correct positioning during measurements. The sites of deformation

measurement were located just under the sites at which load was applied and in the middle between them, i.e. in the middle of the span.

Measurements were taken successively at all points by one and the same indicator-comparator (Fig. 1,b, size "A").

Since for the above-described scheme of load application there occurs a pure bending in the middle part of the beam and the beam bending axis is roughly the arc of the circumference, we assumed that measurements at three points of the pure bending of the beam are reliable for defining the curvature (in this area) and therefore for defining, whenever necessary, longitudinal deformations, too.

To define the breaking load applied according to the beam by the above-described scheme in the form of two concentrated forces applied for a short time to the ends of the middle third part of the specimen, we tested three beams from each group.

The breaking load of the experimental concrete beams of two months in age was equal to 6 MPa for the group of specimens prepared from concrete with water-saturated pumice aggregate and to 5 PMa for the other group prepared from concrete with pumice aggregate saturated with a 0.5% $CaCl_2$ solution.

Because of a relatively small difference between the obtained values of breaking loads for both groups of experimental specimens at the age of two months and in view of the fact that $CaCl_2$ is an accelerator of cement hardening and that, with a lapse of time, the difference in strength values increases, also with the aim of correct comparison of creep deformations of beams from both groups, all specimens were subjected to durable loading tests and one and the same constant force was applied to them, which was equal to half the breaking force value accepted for pumice concrete with a water-saturated aggregate, i.e. $P=0.5\ P_{break} = 3$ PMa.

Bean deflections were measured by a clock-type indicator-comparator, the division value of which was 1 μm.

The beam creep test duration was 55 days.

Data obtained as a result of tests of the beams are collected in Tables 1, 2 and in Fig. 2, which shows the resulting deformation creep curves of the pumice concrete beams with a water saturated aggregate in one case and with an aggregate saturated with a 0.5% $CaCl_2$ solution in the other case.

The analysis of data in the tables and graphs clearly shows that the creep deformation of pumice concrete with an aggregate saturated with 0.5% $CaCl_2$ solution is an essentially more intensive process than the creep deformation of pumice concrete prepared with a water-saturated aggregate. Hence we conclude that the higher the SAS polarity, the higher its wedging-out action which intensifies the development of creep deformation.

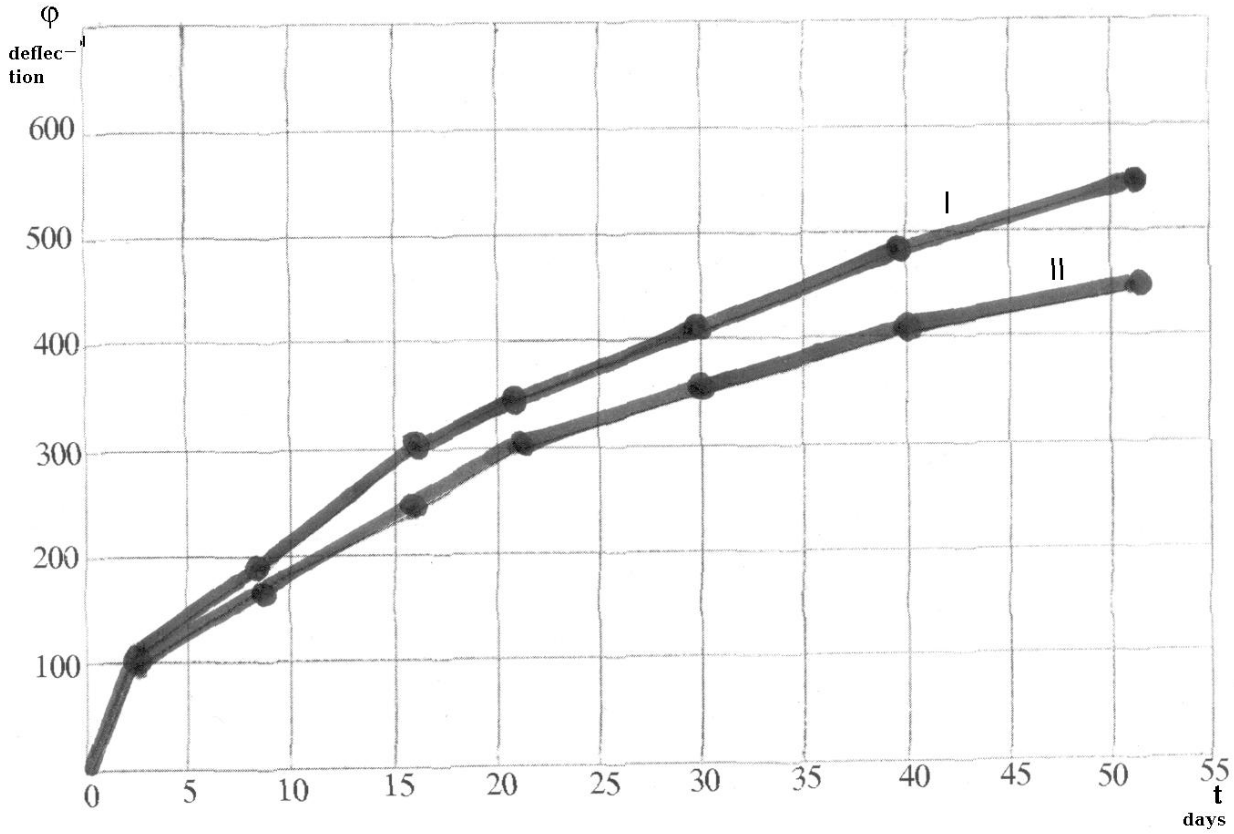

Fig. 2.

I - Pumice Concrete Beams Saturated with 0.5%; II - $CaCl_2$Pumice Concrete Beams Saturated with Water

Data on the Creep of 5×8×60 cm Pumice Concrete Beams Saturated with 0.5% $CaCl_2$

Table 1

Days, T	Specimen I deflection, μm			Specimen II Deflection, μm			Specimen III deflection, μm			Note
	f_1	f_2 max	f_3	f_1	f_2 max	f_3	f_1	f_2 max	f_3	
0	0	(290)0	0	0	(270)0	0	0	(300)0	0	Enclosed in round brackets are deformations due to short-time loading
1	60	80	50	30	75	35	70	75	50	
2	70	100	70	60	110	50	85	100	70	
8	140	180	145	130	210	120	140	195	150	
16	220	300	230	210	305	180	170	260	230	
21	260	350	290	240	375	220	270	330	270	
30	320	400	330	250	420	240	330	400	300	
40	380	480	380	280	500	265	360	485	350	
52	425	540	400	300	550	275	385	560	370	

Data on the Creep of 5×8×60 cm Pumice Concrete Beams Saturated with Water

Table 2

Days, T	Specimen I			Specimen II			Specimen III			Note
	deflection, μm			deflection, μm			Deflection, μm			
	f_1	f_2 max	f_3	f_1	f_2 max	f_3	f_1	f_2 max	f_3	
0	0	(240)0	0	0	(230)0	0	0	(220)0	0	Enclosed in round brackets are deformations due to short-time loading
1	50	60	30	60	70	60	50	55	40	
2	70	100	70	85	100	80	80	90	80	
8	130	170	140	150	190	140	130	160	120	
16	170	245	190	210	280	210	190	230	175	
21	200	300	230	250	340	280	220	270	200	
30	250	360	260	290	390	305	250	310	230	
40	280	405	300	320	420	335	280	365	260	
52	310	450	330	360	470	370	300	415	285	

R E F E R E N C E S

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