Influence of temperature on size of creep of the cement pastes

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Abstract: The article deals with the effect of temperature load before the test of creep on its size after finishing of measurement. Various cement paste mixtures are compared with the results obtained. The cement paste were loaded by temperature, before measurement of creep.The size of creep depending on the moisture content and water-cement ratio is compared at the end.

Keywords: cement paste; creep; shrinkage; temperature; lever mechanism.

1 Introduction

The cement paste is an essential component of concrete. Their function is a binder in concrete. The filler modifies and rather improves the properties of concrete [1]. Therefore, attention is given to the characteristics of the binder component of concrete. The properties of cement pastes are significantly influenced by the amount of mixing water. Our attention is devoted to the the creep of these materials. The temperature can change the properties of building materials. Our attention is focused on the case of load of high temperature before the experiment. Consequently, creep and shrinkage of cement pastes were measured and of them determined the final result.

2 Tested material

The preparation of the cement paste was carried out from cement CEM II and water. Water-cement ratio for the three test mixtures was 0.3, 0.4 and 0.5 [2]. The mixture No. 1 with water ratio of 0.3 was prepared by adding superplasticizer at 3 % for better processing of mixture. All mixtures were older than one month.

3 Testing procedure

The specimens were exposed to temperature of 300 °C for 2.5 hours before the test. Then it was cooled to room temperature, see Fig. 1. Firstly, the specimens was removed from the water and dried up loosely in a laboratory environment. All solids were placed in a temperature chamber and load temperature determined by the procedure after a day of drying in the laboratory. The moisture conditions were modified after the temperature load. Temperature 300 °C changes the properties of the cement paste. The question is, how temperature affects the size creep? Furthermore, the density of material and content od free water in the paste can influence on the size of creep.

The creep was measured on samples of 70 mm length, which were placed in lever arch mechanisms (LAM). The diameter of specimens was 10 mm. Specimens were split into dried and fully water saturated groups. The creep of dried cement paste was measured on the two specimens. The shrinkage of dried paste was measured on one body [3]. The same principle was applied to measurement of the water saturated bodies, two bodies to measure creep and one body to measure shrinkage [4].

The volumetric weight was determined before and after the tests. The water content in the cement pastes was slightly changed during the measurement. Creep of the dried cement pastes without the influence of of shrinkage is presented in the Fig. 2, 4 and 6. The curves of creep are significantly variable depending upon on the water cement ratio, as is evident from the pictures. Specimens were loaded with a constant load at the

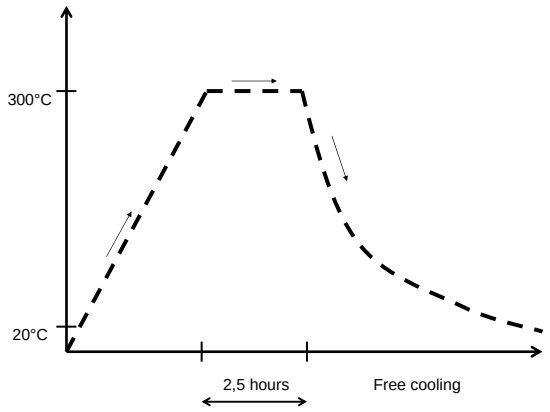

Fig. 1: Principle of temperature loading of cement paste.

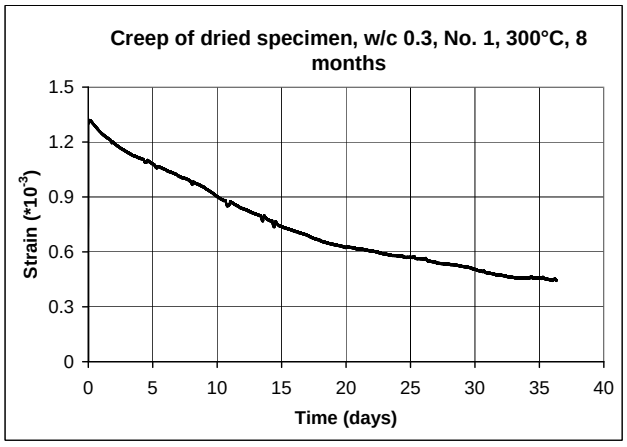

Fig. 2: Creep of dried cement paste. w/c 0.3, without influence of shrinkage.

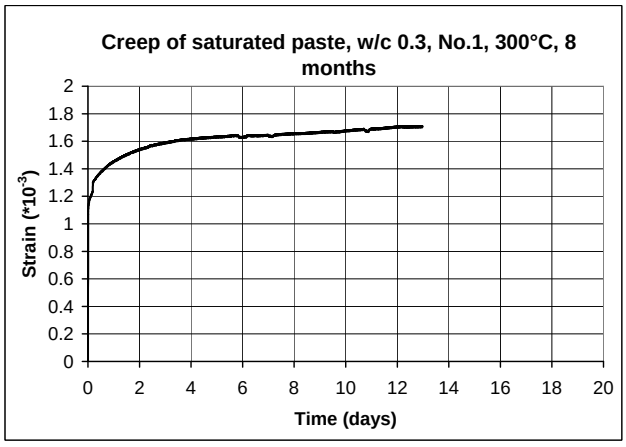

Fig. 3: Creep of water saturated cement paste w/c 0.4, without influence of shrinkage.

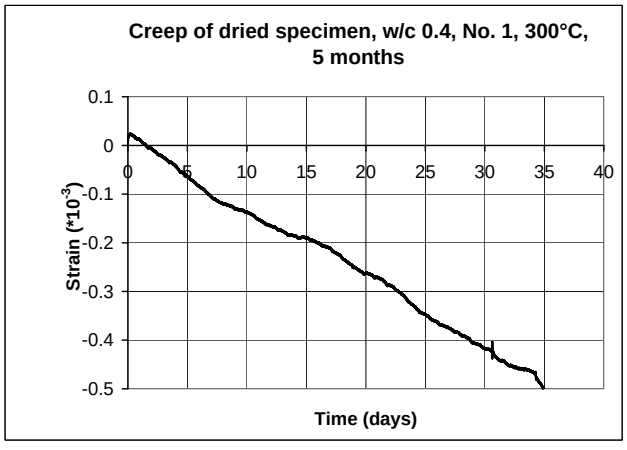

Fig. 4: Creep of dried cement paste w/c 0.4, without influence of shrinkage.

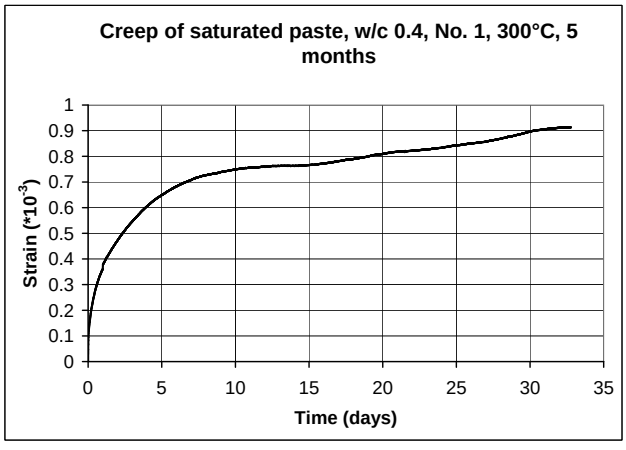

Fig. 5: Creep of water saturated cement paste w/c 0.4, without influence of shrinkage.

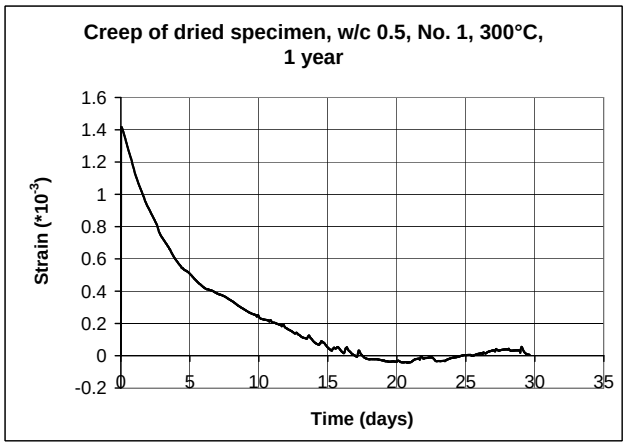

Fig. 6: Creep of dried cement paste w/c 0.5, without influence of shrinkage.

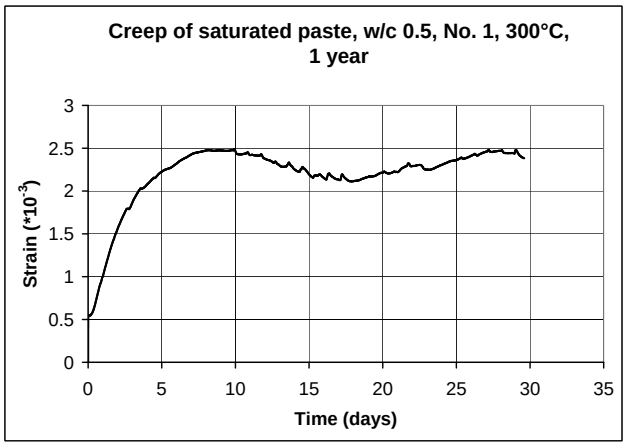

Fig. 7: Creep of water saturated cement paste w/c 0.4, without influence of shrinkage.

beginning of the test. The load was applied to the body throughout the test. The creep of dried specimens has a negative trend. This means that the length of the cylinders is not reduced, but on the contrary swelling.

The creep of water-saturated cement paste is shown in Fig. 3; 5 and 7. Presented graphs are cleaned off shrinkage. Pure creep of saturated cement pastes is shown. The creep of specimens was propagate after weight load in the lever mechanisms at the beginning of the test. There was a decrease in the length bodies as is possible see on Fig. 3; 5 and 7.

The temperature influence on the creep is negligible. This was reflected on the shape of the curves in the graphs on Fig. 6 and 7. Reducing the temperature by 2 °C caused a reduction in the rate of creep of the dried paste and the reduction in the rate of creep of water saturated paste. However, the trend of creeping dry and saturated paste is retained.

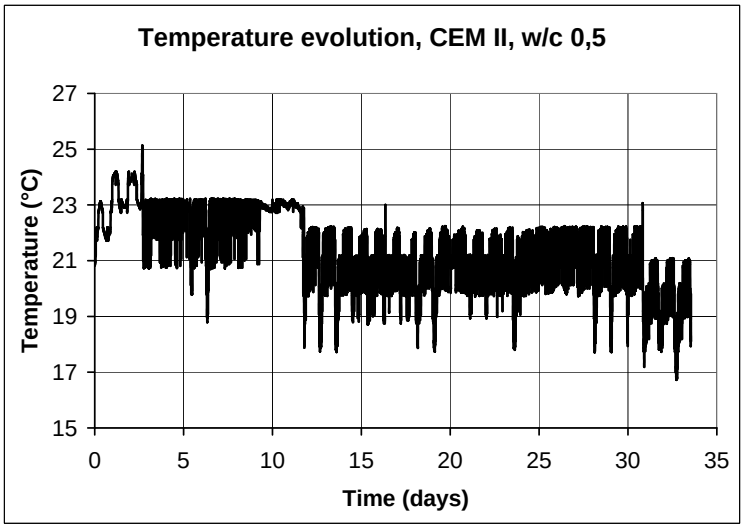

Fig. 8: Evolution of temperature for mixture with w / c ratio 0.5.

4 Results

The curves presented on Fig. 2 - 7 includes creep without shrinkage. The length of measurement was near to 30 days in all three cases. The highest rate of increase in deformation saturated cement paste is 2 days for the w / c 0.3, hereafter 6 days for the w / c 0,4 and 8 days for the w / c 0.5. Then, a rate of increase of deformation decreases. It can be concluded that extending the period in which comes moment of slowing the rate of increase of deformation and the increasing value of water-cement coefficient. The increase of deformation saturated paste is stable after 10 days testing.

Tab. 1: Results of size of creep after 25 day long measurement.

Series	w/c	Sat.	Sat.	Dried	Dried	Basic creep	Basic creep
		1	2	1	2	1	2
1	0.3	0.639*	0.564*	-0.725	-0.884	0.671	-0.094
2	0.4	0.843	0.438	-0.375	-0.411	-	-
3	0.5	1.876	2.470	-1.420	-1.508	-0.445	-0.588

* -values after 12 days (measurement terminated in 13 day).
Values in the table are in microstrains.

A different shape curves represents a dried pastes. Slowing deformation growth is not as easy to see like in the case of the saturated paste. A slowdown occurs after 15 days of testing. Cement paste with w / c 0.4 shows no slowdown. On the other hand, the cement paste with a water ratio of 0.5 shows stop the growth of deformation after 20 days. This is caused by change of environment temperature, which is shown in Fig. 8.

5 Conclusion

The results are summarized in Table 1. The data are determined to 25 day of measurement. The size of creep increases with the water content in pastes. The creep depends also on the amount of free water in the cement paste. The shrinkage of cement paste plays a significant role in the size of creep. This is evident for comparing the columns of the table Dried and Basic creep. Importance of shrinkage increases with the size of water-cement ratio. The shrinkage of very fluid mixtures (line 3 in the table) can make up more then 50 % of creep of dried cement paste.

The data listed in Table 1 relate to creep including the effect of shrinkage beyond the data of basic creep. The basic creep and creep dried paste is comparable in set 1 and 3. The difference values are caused by shrinkage. Shrinking the size of the dried material is not insignificant. It can be stated that reducing the amount of water has a positive effect on the size creep, see comparison of row 2 and 3 in the Table 1. Significance of the temperature load and water-cement ratio was reflected in the higher levels of creep and shrinkage than other materials based on cement composites [5].

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