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Creep of Cement Paste with Content of Fly Ash

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Abstract: The size of cement paste creep depend on the compose of mixture. The creep and shrinkage was measured during 45 days long test. The small specimens were tested in lever mechanism in wet and dry conditions. From uniaxial compression tests was determined compression strength.

Keywords: Cement Paste; Creep; Shrinkage; Compression Strength; Fly Ash.

1 Introduction

The knowledge about the size of creep and shrinkage of the cement paste with fly ash are important for the reliable design of structures included this material. Long-term research is focused on the measurement of the creep of cement pastes with addition of various quantity of the fly ash. Cement paste with fly ash is comparable material with the pure cement paste. But, evolution of the properties is different to cement paste without fly ash [2].

2 Test of Material

The useful specimens are prepared from cement, water and fly ash. Relation between content of water and cement with fly ash is called water - cement, fly ash ratio. The Portland cement PC I, 42.5 R was used for mixture. Water / cement ratio was 0.4. The classical fly ash from coal power plant Mělník was used for the mixture [2,6]. The relation in the mixture between weights of cement and fly ash was 70 / 30. The age of tested cement paste was 3 months. All specimens were placed into the water basin for whole time of maturation.

The specimens for creep testing were concreted into the plastic moulds of cylindrical shapes. The diameter of the specimens for the creep was 10 millimeters. The length of these specimens was 70 mm, see Fig. 2. The size of creep is influenced by the temperature and humidity, too [1, 3]. The temperature in the laboratory was maintained on the 20°C. The research was divide on the test on dried material and saturated material. Three specimens were tested in dry condition. Two specimens were loaded under load 600 N and third specimen was unloaded. Next three specimens were tested in saturated condition. Like a first case, under the saturated condition two specimens were loaded by power 600 N and one specimen was unloaded. All specimens were covered in the plastic foil for control humidity during test. The size of shrinkage was 16 microns after 45 days.

On the other side, the specimens used in compression tests had cross section areas defined by height 10 mm and width 10 mm, too. The length of the specimens was 50 mm. The compression tests were realized on the six specimens, see Fig. 1. The Modulus of Elasticity was determined too from compression tests, see Fig. 6. It was calculate from data of axial deformation of specimen and measured by extesometer and compression stress. In this case was used destructive method for the determination od Modulus of elasticity, opposite the nondestructive method [5]. The prism specimens are suitable for determination of tensile stress in bending [4]. There is usable full length of specimens 100 mm.

3 Results of Creep Measurement

The measurement was finished after 45 days from start. The differences between dried and water saturate cement paste are visible on the Fig. 3. The dried specimen had trend of length increasing, see Fig. 3, left.

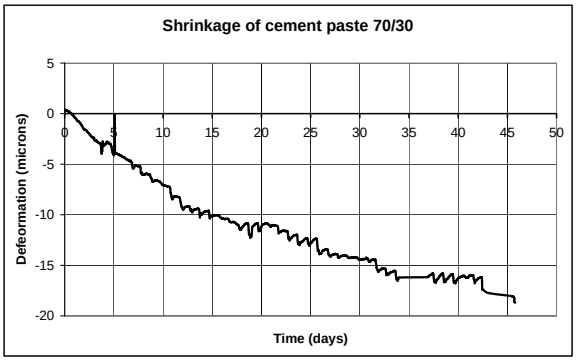
During 45 days the length was increased about 17 microns. On the other side the length of water saturated specimen was reduced about 80 microns. The differences between the creep of dried and saturated cement paste is visible, too. A comparison of diagrams displayed in Fig. 4 and Fig. 5 this effect described cleanly. The dried specimens had the chance of length about 14 microns. The length of specimens was increased after loading by weight during 45 days. Effect of weights at the beginning reduce the length of the specimen of approximately 60 microns.

The saturated cement paste had another progress. The length decreases about 50 microns at the beginning. After loading the size of specimen start decreased, but not too rapidly like on the begin. The change of length was near to 150 microns after 45 days. The quicker increasing of deformation was in firs five days. The rate of deformation was near to 2.25 microns per day after fifth day.

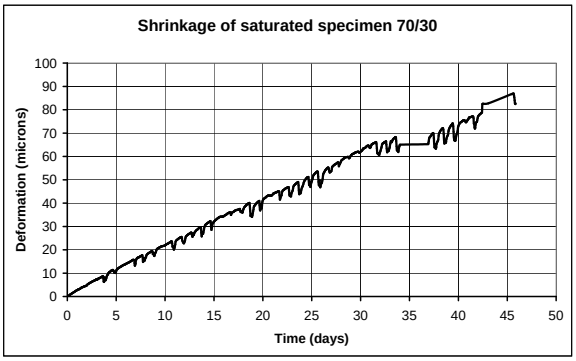
All measurements of creep are influenced by shrinkage. The mark of shrinkage depends on the humidity condition of cement paste. The sign of the shrinkage is positive (length of specimen increase) if cement paste is dried. The negative sign of shrinkage is in case the saturated cement paste. Then length of specimen decreases.

Fig. 1: The prism specimens for compression tests.

Fig. 2: Six specimens for creep and shrinkage tests.

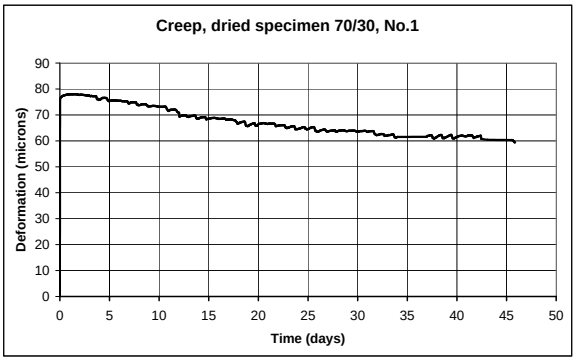


(a) shrinkage of dried specimen

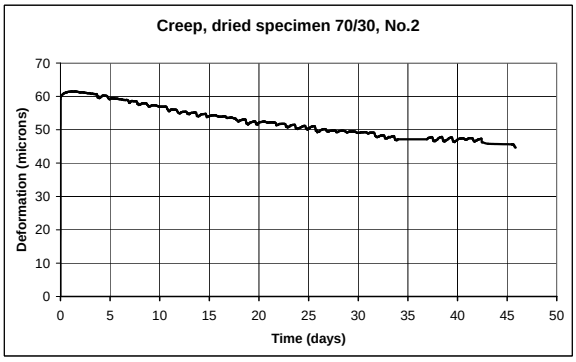


(b) shrinkage of saturated specimen

Fig. 3: The curves of deformation of cement paste unloaded and loaded.

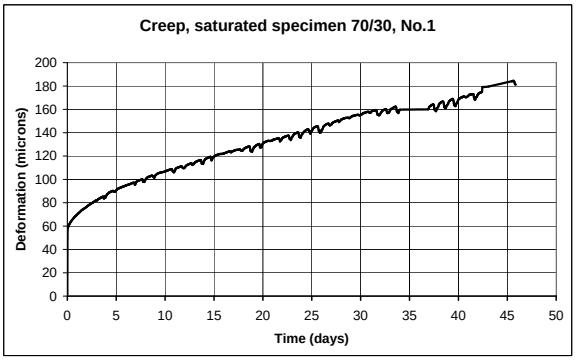


(a) creep of dried specimen No.1

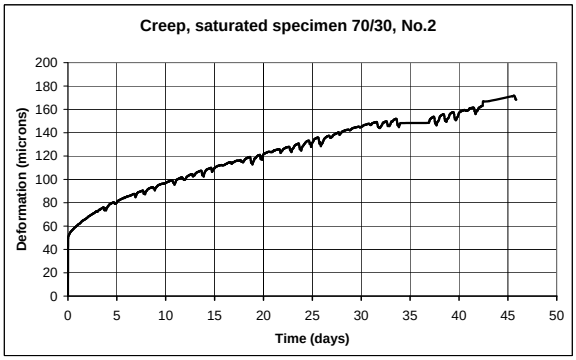


(b) creep of dried specimen No.2

Fig. 4: The curves of deformation of cement paste unloaded and loaded.



(a) creep of saturated specimen No.1



(b) creep of saturated specimen No.2

Fig. 5: The curves of deformation of cement paste unloaded and loaded.

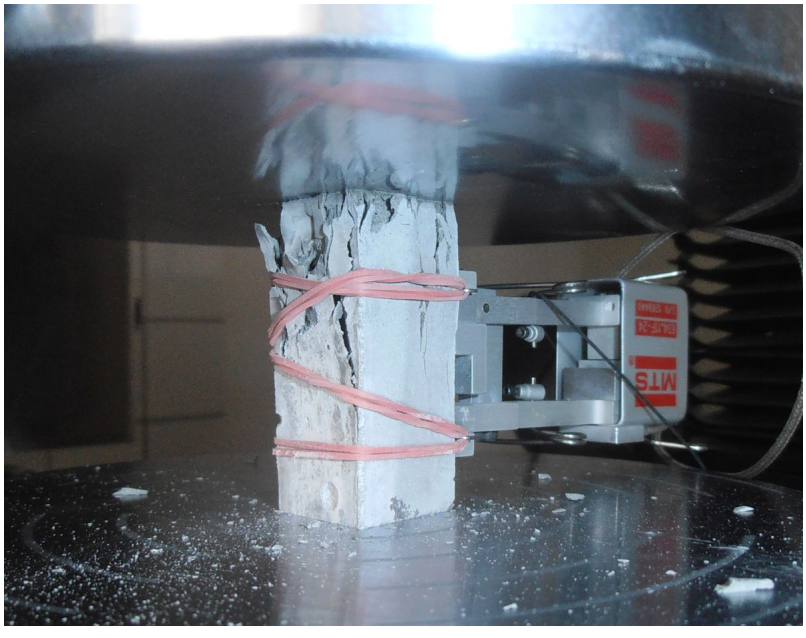


Fig. 6: Compression test of prism specimen with instrumentation of the extensometer.

4 Conclusion

The graphs display the shrinkage and creep of the dried cement paste with fly ash on the Fig. 3 - Fig. 5. The curves in the Fig. 4 and Fig. 5 includes creep influenced by shrinkage of the dried and saturated [1–3]. The creep of water saturated cement paste with 30 % fly ash was decreased about 150 microns after 45 day. The dried cement paste achieved the change of deformation near to 14 microns as the effect of creep. Size of creep depends on the content of water in cement paste. The dried cement paste had lower tendency to change of dimension than the water saturated material. As stated above, the change of humidity brings a fundamental change in deformation characteristics.

The average volume density of water dried cement paste was 1526 kg/m^3 and average volume density of water saturated cement paste with 30 % fly ash was 1910 kg/m^3. The content of the 30 % fly ash in cement paste is possible cause change of weight about 400 kg per m^3. The average compression strength of the cement paste with fly ash was 61.2 MPa.

Acknowledgement

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