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Variation of Early Age Autogenous Shrinkage with Ph of Water at Elevated Temperature

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Abstract: For structural design and rather insufficiently treated in standards, it is complicated to control the early age shrinkage and is a great challenge to determine the properties involved for the volume changes. Early age shrinkage lies in drying, thermal and autogenous stages. Autogenous shrinkage of cement paste is the macroscopic volume change occurred if no moisture transfers to the exterior surrounding environment. The main motto of this paper is to evaluate the effect of pH of water on the early age autogenous shrinkage of cement paste at elevated temperature. The experimental setup has been performed in twelve special type glass bottles, where four different types of Portland and ordinary Portland cement are taken maintaining the pH of water 5,7,10 respectively. Besides measuring the effect of pH on early age autogenous shrinkage, the effect of temperature also investigated. For investigate the temperature effect the experiment was performed at 40°C temperature. It is observed that the early age autogenous shrinkage of cement paste is greater for lowering pH (5) means for acidic water and its value is abridge for greater pH(10) means for alkaline water. It is also investigated that if temperature increases than the shrinkage value also increases. Therefore, this paper gives idea to predict the early age autogenous shrinkage with a variation of pH of water for different cement at 40°C and comparative performances of cement.

Key words: Early age shrinkage · Early age autogenous shrinkage · PH of water · Volume change

INTRODUCTION

A good knowledge about the mechanical behavior of materials is always preferable for the use of materials in structural purposes. Shrinkage is a very important property for the cement based materials and it generates either early age or late age cracking [1]. When cement paste placed up to 24 hours, then the occurring volumetric changes termed as early age shrinkage. Three different stages are assumed to include for the volume changes of cementitious materials at early age. One of them is autogenousshrinkage which is a result of the chemical shrinkage involved with the cement Hydration process and with low water to binder ratio, w/b, it offers high value [2]. Second one is the thermal dilation which is related to the thermal expansion of the material and the exothermic nature of the hydration reactions related with the temperature changes of the cement paste [3]. Next one is the drying shrinkage which refers to the brevity in cement paste volume resulting from a loss of water. For the loss of water which escapes to the cement surface as bleed water causes reduction in its volume and finally shrinkage results [2]. Particularly in the early age autogenous shrinkage of cement paste contributes significantself-generated stress in restrained sections and increases the cracking probability. The phenomenon of autogenous shrinkage is caused by the negative pressure due to self-desiccation with hydration process. It is affected by moisture and pore structure (pore distribution and porosity) of the material, temperature variation, water quality etc. It is expected that autogenous shrinkage under drying conditions differs from that under sealed conditions when the influence of drying on hydration is consider, especially in the case of at an early age [4]. In order to de-couple the thermal and autogenous deformations thematurity concept is usually applied to predict autogenous deformations under realistic temperature conditions. The assumption this concept is that the temperature influence on the hydration rate is independent on the hydration reaction.But several studies have shown that therate and the magnitude of autogenous shrinkage of cement paste were influenced by

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temperature [3].For avoiding the risk of cracking in hardening cement temperature criteria need to judge [5]. With the increasing of temperature water extract from the surface and wrap its volume, finally create pore space in its body. At elevated temperature significant volume change occur means its reducing capacity is greater than the normal temperature. Due to drying shrinkage and autogenous shrinkage water lost within the cement paste. In this study only the autogenous shrinkage is related by sealing the whole system. Within the cement paste the tensile stresses are generated and pull the cement paste close together which attributes a volume reduction. Since autogenous deformation depend on the fineness, the chemical composition of the cement, particle and also the pore size distribution of the cement paste. During self-desiccation by the size of the pores that are being emptied autogenous stresses are controlled that is responsible for the shrinkage. It could be estimated form chemical and mineral composition of cement. On the chemical composition and degree of hydration of C_3A and C_4AF the autogenous shrinkage largely depends [6]. The finer grain of cement leads to greater shrinkage starting at an earlier age and the degree of hydration of cement has an influence on water quality parameter. After the casting of the cementitious material early age autogenous shrinkage need to measure and continuously reading should be taken. Based on Le Chatelier's principle this paper shows a new approach for the determination of early age autogenous shrinkage of cement past [6].

The main objective of this paper is to introduce a test procedure for the measurement of early age autogenous shrinkage and to evaluate the influence of water quality parameter like pH on the early age autogenous shrinkage at elevated temperature. It also focuses temperature effect and help to make decision for controlling the shrinkage which quality water is most suitable for hydration.

Experimental Details

Materials: For the experimental program four different types of cement are used for conducting early age autogenous shrinkage of cement paste at 40°C temperature and humidity 70 percent and water with pH 5, 7 and 10. To make pH of water 5 dilute sulfuric acid is used and to make pH of water 10 NaOH is used.

Apparatus and Specimen: Based on Le Chatelier's principle air tight chamber mainly glass bottle are used for the determination of early age autogenous shrinkage of cement paste in this experiment. The capillary pressure developed inside the glass bottle when the glass bottle keeps under air tight condition. By a rubber cork with capillary tube tightly griped with the head the glass bottle is making. Cement an amount of 200 gm for each are taken for different glass bottle containing pH 5, 7 and 10. 40°C temperature and 70% humidity is maintaining its surrounded environment. Finally all the specimens inserted into a temperature controlled chamber with electrical relay.

Methodology: Firstly the cement of each kind was sieved by #200 sieves before it was placed in the oven at a temperature about 105°C for 2 hours. Each types of cement were then mixed differently with different pH containing water like 5, 7 and 10. Then manually mixed cement paste inserted into the glass bottle by maintaining the top surface of the cement paste inside the bottle almost parallel. The surrounding atmosphere temperature was kept constant 40°C inserting a heater into a prefabricated special box where temperature were controlled by electrical relay. The bottles used for the experiment that were about 22cm height with 8 cm diameter. After inserting the cement paste inside the glass bottle, the blank portions of the bottles were filled with water.

Then the rubber cork in addition with the capillary tube attached with the bottle, due to capillary pressure some water rise up in the capillary tube. Twelve glass bottles for four different brand cement with varying pH kept side by side. When hydration starts with time the cement paste getting shrunk and the water level in the capillary tube lowered and this lowering water indicates the volumetric shrinkage, which is early age shrinkage at autogenous condition. Water inserted manually into the capillary tube when the water level out of reach of capillary tube so that process was not hamper. Initially the readings from the tube of each bottle were taken at an interval of 5 min., then after some period 10 min. interval. After going to harden state the time interval extend to 30 min., then 60 min. and after one day it was 3 hours.

RESULT AND DISCUSSION

From the experimental value of four cement one ordinary Portland and three Portland composite) it is seen that there has an increase nature in autogenous shrinkage. But the increasing rate is varies for different pH of water. The experiment was performed at 40°C temperature on the basis of early age condition. Initially the volume changes occur rapidly and after its initial setting it changes slowly.

Fig. 1: Experimental setup of early age autogenous shrinkage at elevated temperature

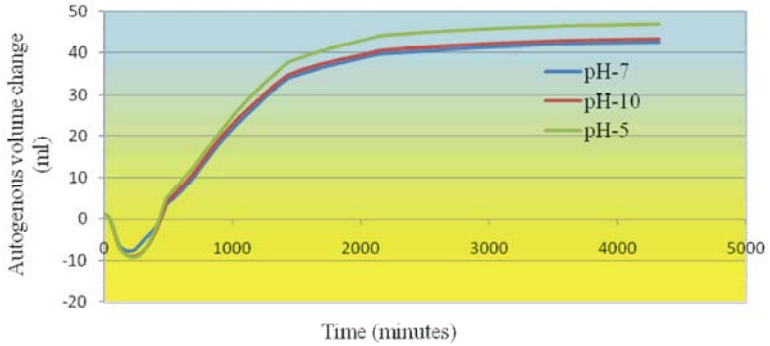

Fig. 2: Variation of autogenous shrinkage for different pH of PCC-1.

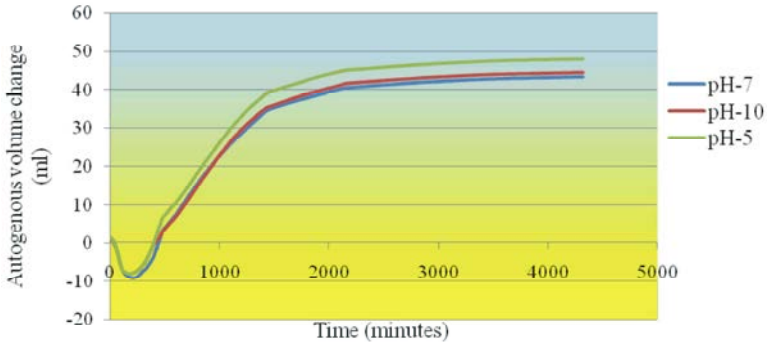

Fig. 3: Variation of autogenous shrinkage for different pH of PCC-2.

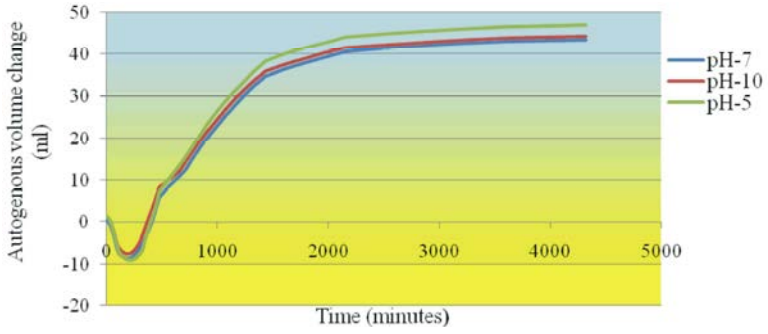

Fig. 4: Variation of autogenous shrinkage for different pH of OPC-1.

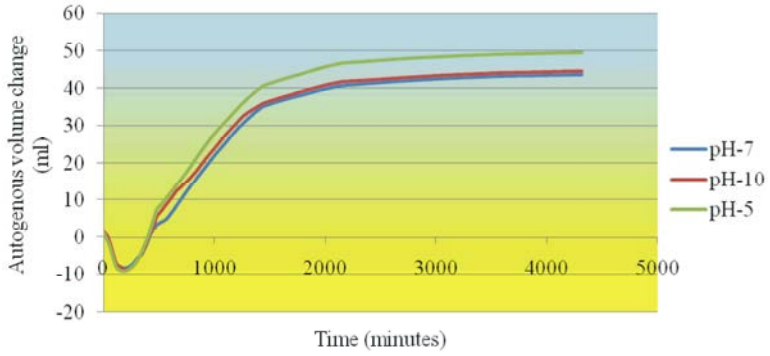

Fig. 5: Variation of autogenous shrinkage for different pH of PCC-3.

The most important fact of this experiment is that the autogenous volume change is greater for pH -5 with comparing to pH-10 and pH-7. The higher temperature also has some effect for much shrinkage. However, the acidic water is more suitable for creating higher shrinkage in cement paste.

From the figure 2 it is observed that the increase in shrinkage volume for PCC-1 is much for the water whose pH is 5. But the increasing value for pH-10 and pH-7 is approximately nearer to each other but not equal.

From the figure 3, 4 and 5 it is shown that the increase in shrinkage volume for OPC-1, PCC-2 and PCC-3 is much for the water whose pH is 5 with comparing to pH-10 and pH-7. Finally, it is concluded that pH of water has a great influence for the shrinkage value.

CONCLUSION

From the result after performing the experiment and investigating previous work it is summarized that decreasing the pH of water used for mixing, early age autogenous shrinkage increase consequently due to the chemical properties of cement and chemical reaction between cement and water in hydration process. The increasing temperature also responsible for create greater autogenous shrinkage.

REFERENCES

1. Loukili, Ahmed., Chopin, David, Khelid, J. Abdelhafid, Touzo and Le.Jean-Yves, 2000. A new approach to determine autogenous shrinkage of mortar at an early age considering temperature history, Cement and Concrete Research, 30: 915-922.
2. Holt, Erika E., 2001. Early age autogenous shrinkage of concrete, Technic Research Centre of Finland, VTT Publications, 446(184): 9.
3. Mounanga, Pierre., Baroghel-Bouny, Ve´ronique., Loukili, Ahmed., Khelidj, Abdelhafid., 2006. Autogenous deformations of cement pastes: Part I. Temperature effects at early age and micro-macro correlations, Cement and Concrete Research, 36: 110-122.
4. Yang, Yang., Sato, Ryoichi, Kawai and Kenji, 2005. Autogenous shrinkage of high-strength concrete containing silica fume under drying at early ages, Cement and Concrete Research, 35: 449-456.
5. Sule, M., Breugel and K. van, 2004. The effect of reinforcement on early-age cracking due to autogenous shrinkage and thermal effects" Cement and Concrete Composites, 26: 581-587.
6. Hasan, M.Y., Rokon, Rashid, Muhammad Harunur, Rahman, S.M. Arifur, Alam AND Salma, 2013. Influence of Treated Water on the Early Age Autogenous Shrinkage of Cement Paste, International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, 02(01): 40-44.