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EXTENDED ABSTRACT

Evaluation of Impact Strength of Heated Slag Geopolymer Concrete

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1. Introduction

In this study, 6 mixing designs including 1 design of control concrete containing Portland cement, 3 designs of geopolymer concrete containing 0 to 8% nanosilica and 2 designs of slag geopolymer concrete containing nanosilica and 1 and 2% of polyolefin fibers were made (Mansourghanaei[1] et al., 2022; Mansourghanaei[2] et al., 2022; Mansourghanaei[3] et al., 2022). In line with the prepared mixing plan, 54 concrete specimens were made for impact test (each test averaged the results of 3 concrete specimens) and 24 concrete specimens were made for compressive strength test (each test averaged the results of 4 concrete specimens) which at the age of 90 Fasts were tested and evaluated. It should be noted that for SEM and XRD tests, shredded tests were used. Concrete compressive strength test was performed at room temperature and impact weight test at room temperature and temperature of 300 and 600 ℃ In the drop weight test, parameters such as impact energy due to initial cracking and failure, adsorbed energy and flexibility index of concrete samples were calculated and evaluated. In order to study the microstructure and verification of the results of hammer impact test, XRD and SEM tests were used on concrete samples.

2. Methodology

Replacement and use of materials containing aluminosilicate particles instead of cement in concrete, leads to the production of geopolymer concrete, which reduces the consumption of fossil fuels, while preserving the environment by reducing the toxic gases of carbon dioxide. The term geopolymer was first coined in 1950 by Professor Glukhovsky in the former Soviet Union and was subsequently explored by Joseph Davidovits in 1979 (Diegles et al., 2018). Materials containing aluminosilicate particles are known as precursors in the production of geopolymer concrete, which in the presence of alkaline materials lead to a chemical reaction and produce hydrated gels, which fill the pores in the concrete and bond between other components. They increase the mechanical properties of geopolymer concrete.

3. Results and discussion

The results of the impact hammer test are shown in the diagram of Fig. 1. Finding and reducing the energy required for initial cracking and failure in concrete samples. In geopolymer concrete, the application of heat of 300 ℃compared to 20 ℃has reduced the number of strokes in the occurrence of initial cracks for designs 3, 4 and 6, but the number of strokes of designs 2 and 5 in this temperature range increased compared to 20 ℃ Gives, at a temperature of 600 ℃for all designs, we see a reduction in the amount of shocks for the initial cracking. With the occurrence of failure in the sample of geopolymer concrete under the temperature of 300 ℃, we see an increase in the number of blows in all geopolymer concrete designs and the number of these blows after applying the temperature of 600 ℃has followed a decreasing trend.

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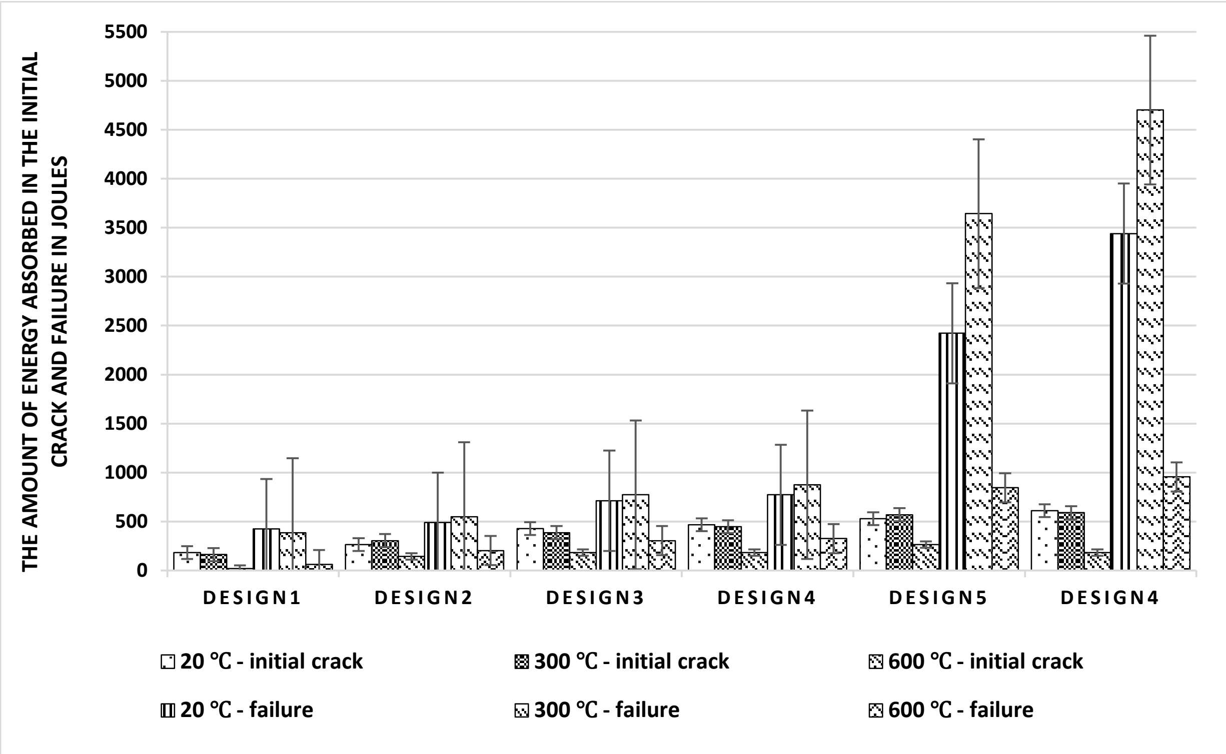

Fig. 1. Graph of The Amount of Energy Absorbed in the Results of The Hammer Drop Test

Increasing the consumption of nanosilica and polyolefin fibers in geopolymer concrete has improved the results of hammer impact test, this is due to the role of adhesion, filler and nucleation of silica nanoparticles in geopolymer cement mortar and the final products of geopolymerization. The fibers reduce the stress concentration at the tip of the crack, thereby delaying the development of cracks in the concrete specimen and increasing the bearing capacity of the concrete specimen. The impact resistance of concrete specimens against falling hammers in the presence of fibers far exceeds the existence of Nanosilica is in the concrete sample. Fig. 2 shows images of concrete specimens after a hammer drop test.

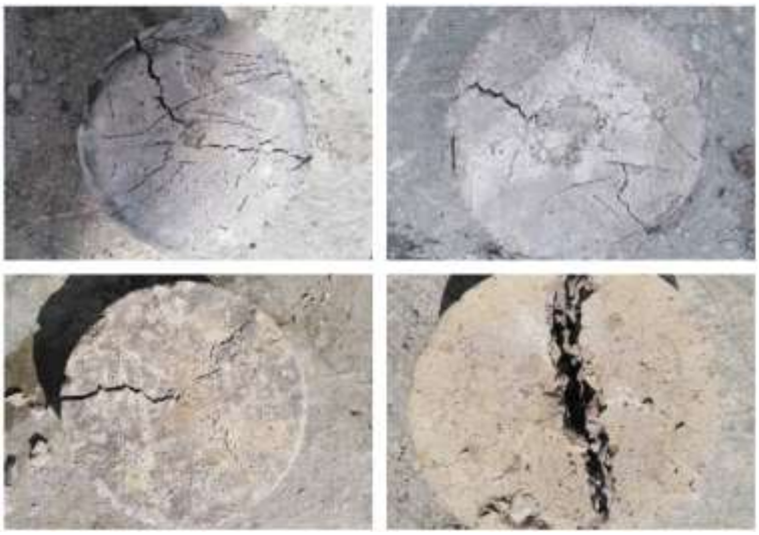

Fig. 2. Images of Concrete Specimens After Hammer Impact Test

In XRD studies, two elements of silica (SiO_2) and calcium manganese carbonate ((Mg.064Ca.936) (CO_3)) are seen in each of the pre- and post-heating spectra in concrete samples, the third element in the previous spectrum. From heat, it is sodium aluminum silicate ($NaAlSi_3O_8$), but in the post-heating sample, calcium aluminate (Na, Ca) is sodium (Na, Ca) Al (Si, Al) $3O_8$, in both spectra there are elements containing aluminum and silica particles that strengthen the microstructure and strength of the concreted concrete are evident. SEM images show that by applying heat, water in the pores and capillary spaces between the layers is removed and weakens the microstructure of concrete, but due to the high density of geopolymer concrete, heat causes less damage to the microstructure of geopolymer concrete.

4. Conclusions

Design 6, including slag geopolymer concrete containing 8% nanosilica and 2% polyolefin fibers, was recognized as the optimal design in the performance of hammer impact resistance in all thermal classes.

Plan 6 as the optimal plan, the growth of failure energy by 14.7 and 3.7 times and the growth of absorbed energy by 18 and 12 times, also the growth of flexibility index by 0.74 and 2.7 times, respectively. To control concrete (Fig. 1) and slag geopolymer concrete without nanosilica and polyolefin fibers (Fig. 2) in heat Has experienced 600 ℃

The results of hammer impact test, XRD test and interpretation of the results of scanning electron microscope images on samples of control concrete and slag geopolymer concrete were in coordination and overlap.

5. References

Diegles S, Felipe J, Ana BRP, "Comparative analysis between properties and microstructures of geopolymeric concrete and portland concrete", Journal of Materials Research and Technology, 2018, 7, 4.

Mansourghanaei M, Biklaryan M, Mardookhpour A, "Experimental study of the effects of adding silica nanoparticles on the durability of geopolymer concrete", Australian Journal of Civil Engineering, 2022, 1-13.

Mansourghanaei M, Biklaryan M, "Experimental evaluation of compressive, tensile strength and impact test in blast furnace slag based geopolymer concrete, under high temperature", Journal of Civil Engineering Researchers, 2022, 4 (2), 12-21.

Mansourghanaei M, Biklaryan M, & Mardookhpour A, "Experimental Study of Modulus of Elasticity, Capillary absorption of water and UPV in Nature-Friendly Concrete Based on Geopolymer Materials", International Journal of Advanced Structural Engineering, 2022, 12 (2), 607-615.