FOAMED GEOFOLYMER COMPOSITES WITH THE ADDITION OF GLASS WOOL WASTE

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Introduction

In research, the foamed geopolymer composites can be used as insulation in technical structures were tested. The main purpose of the performed research was to analyse the influence of the addition of glass wool waste (Figure 1) in the amount of 3% and 5% by weight on selected properties of foamed geopolymers with matrix based on F class fly ash from the Skawina Combustion Heat and Power Plant in Poland. Glass wool waste was obtained from the demolition of the renovated campus building at the Cracow University of Technology (Cracow, Poland). Waste glass wool samples were separated manually from the C&D waste piles. The exact date of the installation of this old glass wool is not known exactly, but it is estimated that it could have been in the 1990s. 10-molar sodium hydroxide solution and sodium water glass R-145 (2.5 molar modulus; density about 1.45 g/cm³), combined in a ratio of one to two were used as an alkaline activator. As a blowing agent in the production of foamed geopolymers two chemical foaming agents (3% by weight of hydrogen peroxide and 0.5% by weight of aluminium powder) were added to a fly ash based geopolymer matrix. Moulded geopolymer composites were heated in an laboratory dryer for 24 hours at 75°C in the atmospheric pressure. The prepared samples were tested after 28 days. The scope of the research carried out included: density measurements, compressive and bending strength tests, measurements of the thermal conductivity coefficient and results of measurements of changes in thermal radiation in samples subjected to a temperature of 800°C.

Samples

- 0%GW – reference sample
- 3%GW – geopolymer with 3% glass wool
- 5%GW – geopolymer with 5% glass wool

Results

- The compressive strength test and flexural strength tests were carried out according to the method described in the concrete standard EN 12390-3. The tests were carried out on a universal strength testing machine Matest 3000 kN at a rate of 0.05 MPa/s. Six cubic samples of dimension 50 x 50 x 50 mm were prepared and tested during compressive strength tests. Four prism specimens with dimensions: 200 x 50 x 50 mm with a support distance of 150 mm were prepared and tested during flexural strength tests.

- In order to determine the thermal conductivity coefficient measurements were carried out using the HFM 446 Layers device from NETZSCH in accordance with the ASTM C518 JIS A1412, ISO 8301 and DIN EN 12667 standards. Samples with dimensions 200 mm x 200 mm x 25 mm were prepared for the tests. Four repetitions of measurements were made for each of the studied geopolymers.

- The research of thermal radiation was carried out according to the original idea. The samples in the form of plates with dimensions of 100 mm x 150 mm x 50 mm were placed in an electric chamber furnace. The details were the insulation elements, which were arranged in the diagram below (Figure 2). As a sealing element, filling the space between the tested plate and the walls of the furnace chamber, an element made of an insulating material was used that, under the action of temperatures up to about 1500°C. Changes in thermal radiation were examined on the outer surface of the sample (Figure 3) with the use of a FLIR thermal imaging camera with a field of view (FOV) = 38°, thermal sensitivity < 70 mK, measured infrared wavelength range in the range of 7 + 14 µm and pixel size < 15 µm. The camera was set at a distance of 1.5 m from the furnace in which the sample was placed. Measurements were made in the center of the sample at a frequency of 60 seconds for the first hour, with the next reduction in the frequency of the measurement readings until temperature stabilization was achieved. The measurement was completed after three hours.

- The results of the compressive strength measurements. The introduction of the glass wool waste addition made it possible to increase the compressive strength of the tested foamed geopolymers. The greater the amount of waste glass wool added, the higher the value of the compressive strength was obtained.

- In the case of measurements of flexural strength, all of the tested samples had a flexural strength of less than 1 MPa, which made it impossible to record the measurements and present the results, which is common for foamed geopolymers.

Conclusions

This paper presents foamed geopolymer composites with the addition of glass wool waste. The results indicate that glass wool waste can be successfully used to decrease density and thermal conductivity coefficient of foamed geopolymer composites with fly ash matrix. Moreover, the introduction of the glass wool waste addition made it possible to increase the compressive strength of the tested foamed geopolymers. Also results of changes in thermal radiation in samples subjected to a temperature of 800°C showed positive effect of addition of glass wool waste. These results seem to be promising for possible applications of foamed geopolymer composites with added glass wool waste for thermal insulations. However, practical applications require further testing to optimize the mechanical properties of foamed geopolymer composites as well as to conduct further studies such as water absorption or resistance in the various environments.

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