Synthesis and properties of foamed geopolymer materials produced from coal mining by-products

Summary

In the context of the development of a circular economy, innovative solutions such as the use of waste and by-products from various industrial processes to create new materials are playing an increasingly important role in the construction industry. Interest in materials based on secondary raw materials is growing steadily, as evidenced by the more than 200,000 scientific publications available in the ScienceDirect database containing the keywords*: secondary raw materials* and *utilization*. Despite this growing interest, the amount of waste generated in industry continues to increase. An example of such waste raw material is waste rock, a significant proportion of which - around 41% - ends up in landfills. The literature analysis carried out as part of this dissertation revealed significant research gaps in the use of mining waste to produce highly porous geopolymer materials with potential fireproofing and insulation properties.

The studies described in this thesis included step-by-step stages of coal waste management - from the preparation of raw materials, through the synthesis of geopolymer materials, to the production of a foamed geopolymer slab. In the first stage, four raw materials from coal mining were analyzed from mines: KWK Staszic, KWK Wieczorek, KWK Sobieski, KWK Wujek. The selected wastes were then prepared for use as components of geopolymer mixtures and their activation with an alkaline solution was carried out. After 28 days of seasoning, the mechanical and physicochemical properties of the samples were analyzed. Based on the results and the availability of materials, waste from the Staszic and Wieczorek mines was selected for further research. The next stage focused on the use of commercially available blowing agents, used in the production of foam concrete, and additives to stabilize the internal structure of the material. Mainly chemical blowing agents were used in the foaming process. The final step was the development of a laboratory prototype of a foamed geopolymer slab with insulating properties.

The research and analysis carried out confirms that the use of waste rock in geopolymer technology is a promising solution for the management of mining by-products, in line with the principles of sustainable development and a closed-loop economy. Further research work in this direction can contribute to the development of low-carbon building materials with competitive technical performance.