STRESZCZENIE W JĘZYKU ANGIELSKIM

The dynamic development of the cement and construction industries is associated with high greenhouse gas emissions and significant consumption of natural resources. Simultaneously, an increasing volume of waste streams is being generated, particularly industrial by-products with potential for material recovery. This doctoral dissertation addresses the issue of industrial and municipal waste management. The aim of the performed research was to comprehensively assess the potential use of selected recycled materials in the production of cements, mortars, and cement-based concretes. The subject of the study aligns with current research trends in construction engineering focused on reducing carbon dioxide emissions, limiting the consumption of natural resources, and implementing the principles of the circular economy.

The research program included an analysis of the effects of recycled materials, namely copper slag, waste glass cullet, rubber waste, glass composites, as well as carbon fibers, on the mechanical, physical, and durability properties of cement composites. These materials were evaluated in three primary application areas: as partial cement replacements, as substitutes for fine and coarse aggregates, and as dispersed reinforcement. The research theses assumed that the incorporation of recycled waste materials, as partial replacements for conventional components of cement composites, would enable the production of materials with mechanical and durability properties comparable to those of traditional cement-based composites. It was also assumed that recycled materials could function as fully valuable constituents of cement composites.

Experimental investigations were conducted in accordance with relevant standards. They included tests of compressive and flexural strength, density, water absorption, freeze-thaw resistance, and durability. The influence of the type of waste material, its particle size distribution, and its percentage content on both fresh mix parameters and hardened concrete properties was analysed. The results demonstrated that properly prepared and dosed waste materials can effectively replace a portion of cement or natural aggregates without significant deterioration of mechanical properties. In some cases, improvements were observed in selected parameters, such as crack resistance, freeze-thaw resistance, and reduced composite density. Simultaneously, threshold values for the content of waste materials were identified, beyond which a significant decrease in strength or durability occurred. The study also evaluated the effect of waste material fineness on pozzolanic activity and the properties of cement paste. It was shown that appropriate pre-treatment of waste materials, including drying, sorting, and grinding, is crucial for achieving consistent mechanical performance of concrete.

The conducted research and its analysis confirmed the validity of using the investigated recycled waste materials in concrete technology, provided that appropriate preparation procedures and quality control are maintained. Furthermore, the dissertation has practical applicability and makes a significant contribution to the development of sustainable concrete technologies. The performed tests and obtained results provide a basis for further research on the implementation of waste-derived materials in the production of construction products, contributing to the reduction of natural resource exploitation and the carbon footprint of the construction sector.