DEVELOPMENT OF GEOPOLYMER BINDERS WITH MIXED CONSTRUCTION AND DEMOLITION WASTE-BASED MATERIALS

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ABSTRACT

As a consequence of ever-increasing urban population and continuous development of industrialization and economies of countries around the world, construction and demolition industry gained eye-catching popularity, although it is also considered one of the largest producers of solid wastes globally. In an effort to counteract the negative effects of the growing construction and demolition waste (CDW) issue, the current study focused on the utilization of mixed CDW-based materials such as hollow brick (HB), red clay brick (RCB), roof tile (RT), glass (G) and concrete (C) in the production of geopolymer binders. These materials were acquired from the demolished residential buildings in an urban transformation area and then subjected to identical two-step crushing-milling procedure to reach sufficient fineness for geopolymerization. In the first stage of the study, these materials were used singly in the production of geopolymer binders to analyse the effects of material characteristics (*e.g.*, fineness, chemical composition and crystalline nature) on the geopolymerization performance. Thereafter, these materials were used altogether in a quinary mixture to produce geopolymer binders with the purpose of better simulating the real life conditions where CDWs are obtained altogether and time-/energy-consuming to separate. In order to characterize the performance of different CDW-based materials, several mixture designs were made by the use of sodium hydroxide (NaOH) as the alkali activator. After applying thermal curing to the geopolymer pastes, compressive strength tests were performed in addition to the microstructural analyses. Results showed that, compressive strength values of up to 55 MPa can successfully be achieved depending on the mixture proportioning. While RT was found to be the most effective material in terms of mechanical performance of CDW-based geopolymer binders, G and C exhibited poor performances due to relatively coarse particle size distribution and inadequate chemical composition of SiO_2 and Al_2O_3 which is a necessity for an effective geopolymerization. In-depth microstructural analyses supported that the geopolymer pastes with higher compressive strength have a denser and more homogeneous microstructure. The main reaction products of geopolymer binders were mostly sodium aluminosilicate hydrate (N-A-S-H) gels with zeolite-like structures and partially calcium aluminosilicate hydrate (C-A-S-H) gels arisen from the use of C with high CaO content. Our results proved that CDW-based materials can successfully be used in the production of geopolymers can be regarded as promising alternatives to traditional systems based on Portland cement.

Keywords: Construction and demolition waste (CDW); Geopolymer; Compressive strength; Microstructure.