ALKALI ACTIVATED BINDERS BASED ON MUNICIPAL SOLID WASTE INCINERATION BOTTOM ASH

Alex Maldonado-Alameda, Universitat de Barcelona
alex.maldonado@ub.edu
Jofre Mañosa, Universitat de Barcelona
Joan Formosa, Universitat de Barcelona
Jessica Giro-Paloma, Universitat de Barcelona
Josep M. Chimenos, Universitat de Barcelona

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The increase of energy demand and the Municipal Solid Waste (MSW) management are some of the environmental problems that have generated more interest in modern society. These conflicts have as main effects the growth of greenhouse gases (GHG) emissions, global warming and the pollution of the environment and the natural resources. Concerning the building sector, the Ordinary Portland Cement (OPC) is the most polluting material, responsible for 2-3% of the global primary energy consumed and 5-7% of global CO_2 emissions. Therefore, it is necessary to seek an alternative, and one of the most advanced candidates are alkali-activated binders (AABs) because of their similar properties to OPC [2]. Nonetheless, the main benefit exhibited by AABs relies on the ecological side since the CO_2 emissions and the energy consumption associated with AABs manufacturing are lower than OPC manufacturing [3]. In addition, the possibility of using wastes and industrial by-products as raw materials promotes the circular economy and the zero-waste principle. This investigation approaches the scientific and technological development of new AABs based on the alkaline activation of weathered bottom ash (AA-WBA). WBA is a heterogeneous mixture of ferrous and non-ferrous metals, ceramics, glass, and a small percentage of organic matter. Its composition and morphology are very similar to natural aggregates of siliceous origin. In this sense, WBA can be re-use as a secondary aggregate material in the building and civil engineering fields. The high percentage of glass and aluminium in the WBA allows thinking about the potential of this waste as a raw material for the formulation of AABs. The main goal of this resear was the formulation of AA-WBA binders, for non-structural purposes, using secondary resources as main precursors: (i) The entire (0 to 30 mm) and coarse fraction (8 to 30 mm) of WBA (WBA and WBA8/30), as a source of SiO_2, and (ii) PAVAL (PV), a by-product generated during the aluminium recycling process, as a complementary source of Al_2O_3. Different mixtures of sodium silicate (WG) and sodium hydroxide (2, 4, 6, and 8 M) solutions were used as alkaline activators. The physicochemical characterization demonstrated the formation of the C-S-H, C-A-S-H and (N, C)-A-S-H gels. The results also revealed the influence of the concentration of the activator solution on the final properties of the AA-WBA binders. In addition, the high availability of SiO_2 in the WBA8/30 fraction led to an improvement in the mechanical properties of AA-WBA binders. It was also demonstrated the improvement of mechanical performance throughout the inclusion of PV as an Al_2O_3 source. Finally, the environmental characterization through leaching (EN 12457-2 and CEN/TS 16637-2) and acute toxicity (Daphnia Magna) tests evidenced promising results. In this sense, the level of ecotoxicity in the AA-WBA formulated with the 8 to 30 mm fraction is similar to the binders activated with MK (AA-MK).

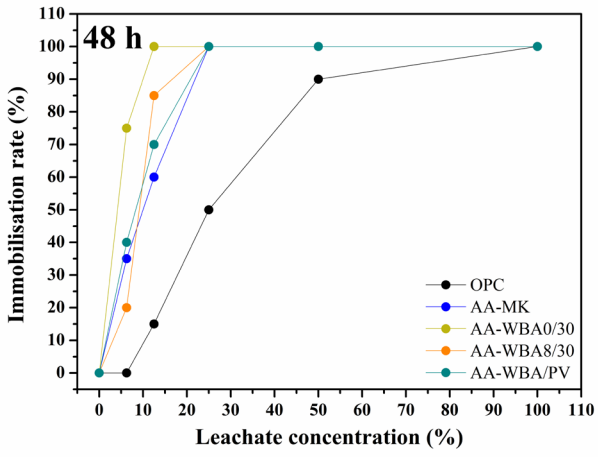

Figure 1. Immobilization rate of Daphnia magna according to the concentration of the leachate resulting from the EN-12457–2 standard.