Development of alkali-activated materials using municipal solid waste incinerator bottom ash as precursor

Summary

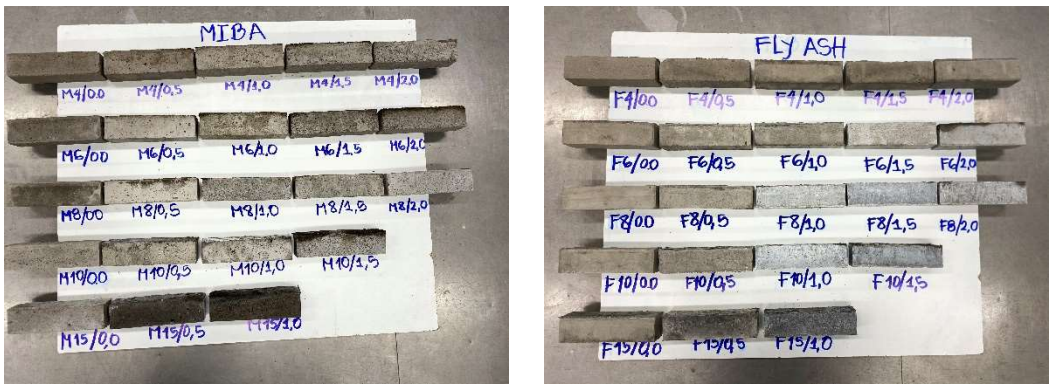
In cement production, high amounts of carbon dioxide (CO_2) are generated in around a 1:1 ratio; for each metric tonne of cement produced, a metric tonne of CO_2 is released, a greenhouse gas widely acknowledged to contribute to global warming. An alternative to the complete replacement of conventional cement in construction materials, thereby reducing CO_2 emissions, is the use of alkali-activated materials (AAM), produced from the polymerization reaction between an aluminosilicate precursor with available amorphous phases and an alkaline solution. Several investigations have proposed the use of aluminosilicate wastes for the manufacture of alkali-activated mortars and/or concretes, mitigating the impact caused by the waste in question, as it is entering the supply chain again. Such is the case of the bottom ashes generated in municipal solid waste incinerators, which are generally sent to landfills.

In this way, the main objective of this research is to assess the potential for alkaline activation of pretreated municipal solid waste incinerator bottom ash (MIBA, from Valorsul, MSW thermal power plant) and fly ash (FA, from Energias de Portugal, EDP at Sines Power Plant) for the development of alkali-activated mortars, by evaluating the properties in the fresh and hardened state.

This work is carried out in five stages: (i) sampling, preparation and characterization of all materials; (ii) selection of the superplasticizer and the adequate pretreatment for the oxidation of metallic aluminum present in MIBA; (iii) analysis of the Na_2O/binder ratio and the silicon oxide/sodium oxide (SiO_2/Na_2O) ratio on the alkali activation of MIBA and FA as precursors; (iv) getting an AAM with the best durability and mechanical properties, yet with the highest possible MIBA content, replacing of FA with MIBA and; (v) characterization of alkali-activated pastes by means of nuclear magnetic resonance (NMR), scanning electron microscopy (SEM), X-ray diffraction (DRX), among others tests.

Keywords

Alkali-activated materials, municipal solid waste, bottom ash, fly ash, geopolymers, reuse of waste, nonconventional binders.



(a) (b)

External view of AA mortars (a) with MIBA as precursor and (b) with FA as precursor.

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