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Investigation of Municipal Solid Waste Incineration Filter Cake as Minor Additional Constituent in Cement Production

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Abstract : Nowadays MSWI (Municipal Solid Waste Incineration) bottom ash (BA) produced by Waste-to-Energy (WtE) plants represents the majority of the solid residues derived from MSW incineration. Once processed, the BA is often landfilled resulting in possible environmental problems, additional costs for the plant and increasing occupation of public land. In order to limit this phenomenon, European countries such as the Netherlands aid the utilization of MSWI BA in the construction field, by providing standards about the leaching of contaminants into the environment (Dutch Soil Quality Decree). Commonly, BA has a particle size below 32 mm and a heterogeneous chemical composition, depending on its source. By washing coarser BA, an MSWI sludge is obtained. It is characterized by a high content of heavy metals, chlorides, and sulfates as well as a reduced particle size (below 0.25 mm). To lower its environmental impact, MSWI sludge is filtered or centrifuged for removing easily soluble contaminants, such as chlorides. However, the presence of heavy metals is not easily reduced, compromising its possible application. For lowering the leaching of those contaminants, the use of MSWI residues in combination with cement represents a precious option, due to the known retention of those ions into the hydrated cement matrix. Among the applications, the European standard for common cement EN 197-1:1992 allows the incorporation of up to 5% by mass of a minor additional constituent (MAC), such as fly ash or blast furnace slag but also an unspecified filler into cement. To the best of the author's knowledge, although it is widely available, it has the appropriate particle size and a chemical composition similar to cement, FC has not been investigated as possible MAC in cement production. Therefore, this paper will address the suitability of MSWI FC as MAC for CEM I 52.5 R, within a 5% maximum replacement by mass. After physical and chemical characterization of the raw materials, the crystal phases of the pastes are determined by XRD for 3 replacement levels (1%, 3%, and 5%) at different ages. Thereafter, the impact of FC on mechanical and environmental performances of cement is assessed according to EN 196-1 and the Dutch Soil Quality Decree, respectively. The investigation of the reaction products evidences the formation of layered double hydroxides (LDH), in the early stage of the reaction. Mechanically the presence of FC results in a reduction of 28 days compressive strength by 8% for a replacement of 5% wt., compared with the pure CEM I 52.5 R without any MAC. In contrast, the flexural strength is not affected by the presence of FC. Environmentally, the Dutch legislation for the leaching of contaminants for unshaped (granular) material is satisfied. Based on the collected results, FC represents a suitable candidate as MAC in cement production.

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