The Influence of Crushing and Magnetic Separation of Cogeneration Power Plant Incineration Waste on the Physical and Mechanical Properties of Concrete

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Abstract

Currently, there are popular cogeneration power plants in the world, which produce electricity and heat energy by incineration process of burning fuel and the fuel consists of municipal solid waste (MSWI). During this process, one of the by-products of the cogeneration power plant is bottom slag of various fractions of MSWI, the use of which currently does not exist on a large scale in Lithuania. MSWI bottom slag from the Lapiai landfill in Lithuania was used for the research. In this work, four different fractions (0/2; 1/5; 4/12; 15/50 mm) of MSWI bottom slag were milled to a particle size of 0.00-0.02 mm, which was cleaned by magnetic separation to extract concentrates of heavy metals. XRF analysis showed that a large proportion of these concentrates consisted of quartz (~28%), iron (~26%), and calcium (~18%). It was also observed that the separation removed a number of alkali metals and others, which can have a detrimental effect on the properties of concrete. After separation from metals, the cleaned and untreated MSWI slag was used in concrete production. 8 different concrete compositions were produced, replacing 10% of the fine concrete aggregate (sand 0/4 mm) with MSWI slag, and one control composition. The largest change in density is when using milled MSWI bottom slag of the largest initial fraction 15-50 mm without magnetic separation, these samples are characterized by a 40 kg/m3 lower density. When using MSWI slag to replace 10% of the fine aggregate in concrete, standard concrete has higher flexural strength in all cases, but using cleaned MSWI slag achieves better results compared to untreated MSWI slag. The results of concrete compression depended not only on the primary MSWI slag fraction, but also on whether the slag was cleaned or not. Porosity tests showed that the porosity of concrete samples in which MSWI slag was used increased by 1 to 2%. Based on the results of this study, it can be said that that more than 150 kg of crushed and cleaned or untreated MSWI bottom slag can be used in the production of 1m3 of concrete. This study may be relevant for more efficient use of MSWI bottom slag in concrete production, as slag milling and additional metal separation should potentially reduce the corrosion effect of undesirable metals of third period of the periodic table of chemical elements on concrete.

Keywords

MSWI, bottom slag, concrete, separation, compressive strength.