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Use of municipal solid waste incinerator bottom ash as aggregate in concrete

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Research about the use of residues from industrial processes and waste incinerators in concrete production is a positive advance in sustainable development by saving natural resources and decreasing waste volume stored at landfills. Today, modern solid waste incinerator plants produce bottom ashes, which are used in building industry. Because of a highly sophisticated reprocessing technique the ashes show a relatively stable composition, comparatively well defined properties and environmentally relevant parameters below legal limits. Due to its chemical and mineralogical characteristics the bottom ash can in principle be used as aggregate in the production of normal strength concrete. However, if the ash contains concrete damaging components, such as chlorides, sulphates, organic compounds, or too large quantities of fines, aluminium and waste glass, recycling becomes problematic. Especially, inclusions of aluminium into the ash particles and a glass content of about 15 % cause considerable cracks, spallings and pop-outs in concrete specimens within a very short time. In the alkaline environment of fresh and hardened concrete the aluminium particles react with water to aluminium hydroxide, aluminates and hydrogen. Furthermore, glass corrosion yield to alkali silicate gels by alkali silica reaction (ASR). Both reactions form voluminous products, which lead to concrete damages.

Studies to minimise these negative factors have discovered possibilities to improve the properties of the bottom ash by additional treatment. An upstream sieving/washing procedure helps removing the fines and organic components. The content of waste glass is reduced to half by opto-mechanical glass separation. A treatment with sodium hydroxide solution reduces the aluminium content to less than 0.4 % and removes

harmful substances, such as chlorides and sulphates.

To evaluate the effect of bottom ash on concrete, concrete specimens were produced with ordinary Portland cement CEM I 32.5 R and aggregates according to the grading curve of B32, whereby the aggregates from 2 to 32 mm particle size were replaced by the treated bottom ashes. Their engineering properties, such as workability, compressive strength, dynamic modulus of elasticity, frost resistance and ASR stability were studied. The results show that the additional treatments improve the quality of the ash. Thus concretes with a compressive strength of C20/25 can easily be produced. However, similar to the use of recycled aggregates, these concretes exhibit a 15 % lower compressive strength and twice the porosity of control specimens containing exclusively natural sand and gravel. But only those concretes, which were made with the ash with low aluminium content from the sodium hydroxide solution treatment, remained free of damage.

The poster presentation gives a survey of the studies to assess the use of municipal solid waste incinerator bottom ash as aggregate in concrete.