Waste-to-energy (WTE) ashes (or called as municipal solid waste incineration ashes) have been recycled in the areas of road bed, asphalt paving, and concrete products in many European and Asian countries. In those countries, recycling programs (including required physical properties and environmental criteria) of ash residue management have been developed so as to encourage and enforce the reuse for WTE ashes instead of landfill disposal. However, the U.S. has shown a lack of consistent and effective management plans as well as environmental regulations for the use of WTE ashes. Many previous studies demonstrated the potential beneficial use of WTE ash as an engineering material with minimum environmental impacts. Due to persistent uncertainty of engineering properties and inconsistency in the Federal and State regulations in the U.S., the recycling of WTE ash has been hindered, and they are mostly disposed of in landfills.

The goal of this study is to identify beneficial use of WTE ashes as construction materials; thus, the recycling program of WTE ashes will become more active in the U.S. One of potential applications for the WTE ashes can be cement-based materials because the ashes contain good chemical components such as calcium and silicon. Moreover, toxics (heavy metals) can be bound or encapsulated in cement matrix; thus, the leaching potential can be reduced. The specific objectives are: (1) to understand the current practice of the reuse of WTE ashes as construction materials, (2) to physically and chemically characterize WTE bottom and fly ashes, (3) to investigate the effects of WTE bottom and fly ashes in cementitious materials (e.g. cement paste and concrete) as replacement of either cement or fine aggregate with emphasis on cement hydration, and (4) to investigate the environmental impacts of WTE bottom ash on leaching when used in cement-based materials.

Fundamental properties of MSWI bottom ash and fly ash were studied by conducting physical, microstructural, and chemical tests. Petrographic examinations, such as scanning electron microscopy (SEM), energy dispersive x-ray (EDX), and x-ray diffraction (XRD) were performed in order to identify chemical composition of the ash and to determine their contents. To evaluate the main side effect of ash when used in concrete, the creation of a network of bubbles due to the presence of aluminum, ashes and aluminum powder were submerged in high pH solution, and the evolution of hydrogen gas was measured.

Efforts were made to investigate the influence of WTE ashes on engineering properties of cement paste and concrete specimens when part of Portland cement and fine aggregate are replaced with ground and sieved WTE ashes. Cement paste and concrete cylinders were cast with various amounts of mineral and fine aggregate additions, respectively, and their strength and durability were investigated. Subsequently, optimum mix proportioning of the WTE ashes was investigated when they are used in cement paste and concrete specimens. In addition, the leaching characteristics of major alkaline and trace elements from concrete containing varied amounts (10%-50%) of BA were investigated by Synthetic Precipitation Leaching Procedure (SPLP) batch testing.
Hae-Bum Yun, Faculty
Manoj Chopra, Faculty
Linan An, Faculty

Approved for distribution by BooHyun Nam, Committee Chair, on October 29, 2015.

The public is welcome to attend.