'Pollution' may be key ingredient in concrete mixtures, researcher says

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(PhysOrg.com) -- A researcher at Missouri University of Science and Technology is leading a study to increase the amount of fly ash used in concrete. If successful, the effort could divert millions of tons of the waste product away from ponds and landfills and reduce CO_2 emissions.

Currently the nation's power plants generate about 130 million tons of fly ash and bottom ash during the coal combustion process. Fly ash - the fine particles that rise with flue gases during combustion - are captured through filtration to reduce air pollution and are often stored at coal power plants or placed in landfills.

Adding fly ash to concrete isn't a new concept. For more than 70 years, the waste product has been a component of concrete used to build the nation's bridges, roads, dams and overall infrastructure. The material increases concrete's durability, extending the service life of these structures. About 43 percent of the material is recycled as components of wallboard or concrete.

"Traditional specifications limit the amount of fly ash to 35 or 40 percent cement replacement," says Jeffery Volz, assistant professor of civil, architectural and environmental engineering at Missouri S&T. "Recent studies have shown that higher cement replacement percentages - even up to 75 percent - can result in excellent concrete in terms of both strength and durability."

Concrete typically has three key components: portland cement, water and aggregates like gravel and sand. During the manufacture of cement, limestone and other materials are heated to extreme temperatures, releasing tons of CO2 from both chemical reactions and the heating process. If fly ash could replace cement, it would not only reduce the amount of fly ash that ends up in ponds and landfills but CO2 emissions as well, says Volz.

High-volume fly ash is significantly more sustainable, but also can be unpredictable. The physical and chemical characteristics of the material can vary, which can change how it reacts to additives.

"At all replacement rates, fly ash generally slows down the setting time and hardening rates of concrete at early ages, especially under cold weather conditions, and when less reactive fly ashes are used," Volz says.

The disposal of fly ash isn't without some controversy. In December 2008, 1 billion gallons of wet coal ash spilled when an earthen retaining wall of an ash pond gave way in Tennessee. Dozens of wells were contaminated with toxic materials, like arsenic and mercury. Soon after, the Environmental Protection Agency began reviewing regulation of the material. While the EPA supports adding fly ash to concrete or using it for soil stabilization, the agency is considering designating fly ash as a hazardous waste. The ruling would attach a stigma to the material despite solid evidence that once fly ash is added to concrete, the material is chemically altered and unable to leach the toxic materials over time.

Still, Volz acknowledges that owners may not want it in their buildings. "Construction workers might refuse to work with it," he says. "And there's also the issue of at what point is it not a hazardous material when used for beneficial reuse. Is it once it is added to the ready mix truck, which means it is a hazardous waste in the silo at the ready mix plant? Or is it once the concrete hardens, which means it's a hazardous waste up to that point?"

Volz is working with the Missouri Department of Transportation to develop guidelines for the proper application of high-volume fly ash concrete in bridges, roadways, culverts, retaining walls, and other transportation-related infrastructure components.

"By nearly doubling the use of reclaimed fly ash in concrete, high-volume fly ash aligns well with MoDOT's green initiative on recycling," he adds.

Provided by Missouri University of Science and Technology

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