Research on Recycling Continues at UWM

The concrete industry is both a cause and a solution in the analysis of greenhouse gas emissions. According to Tarun Naik, a civil engineering professor at the University of Wisconsin-Milwaukee (UWM), the production of 1 ton of cement, the glue that binds aggregate particles together to make concrete, creates approximately equal amounts of greenhouse gases. This puts the cement and concrete industries on the cause side of the discussion.

Naik, who also directs the UWM Center for By-Products Utilization, has devoted the last several decades researching greener alternatives to cement, and has become an authority on the use fly ash to reduce the amount of cement needed in concrete. Fly ash, also called coal ash, is a waste product of coal-burning power plants that usually ends up in landfills. Use of fly ash in concrete puts the cement and concrete industries on the solution side of the ledger. The key is to find ways to continue to increase the use of fly ash and other materials that generate greenhouse gases to the extent that the concrete industry is consuming more by-products than it produces.

The research of Naik and the Center for By-Products Utilization was recently recognized by the U.S. Environmental Protection Agency's Coal Combustion Products Partnership (C^2P^2) for its investigation into other uses for coal combustion products, like fly ash and other by-products generated by coal-burning power plants.

"By using fly ash in place of cement, we cut the corresponding amount of CO_2 emissions," Naik says, adding that the substitution works just as well in most applications where cement is used. "The idea is to be able to use more and more fly ash instead of cement. But currently, most concrete is still made with some cement." The reason, he says, is that the properties of fly ash are altered by the various conditions under which it is generated. The source of coal, type of boiler used to burn the coal, and ash collection process affect the fly ash.

In Wisconsin, the center has worked with We Energies to boost the amount of fly ash made available to the industry for cement production. During its 24-year association with the center, We Energies has increased its sale of fly ash from 5 to 100%. In recent years, the power company has also dug up and sold fly ash that was previously put in landfills.

"Our research with UWM demonstrated that much higher amounts of fly ash could be used along with portland cement to produce concrete of higher strength and quality," says Bruce Ramme, manager of Environmental Land Quality for We Energies.

Besides fly ash, the center specializes in methods of recycling other varieties of industrial by-products into reusable resources—such as foundry sand and slag (also necessary in making concrete), pulverized tires, silica dust from mining operations, wood ash from forest products industries, and pulp and paper mill sludge.

Its research into cement alternatives addresses two environmental issues at once. But there's a potential third solution that involves existing concrete.

By crushing demolished concrete into small pieces and exposing it to the CO_2 in the atmosphere, a chemical reaction will cause the softer lime particles in the concrete to harden, sequestering the CO_2 in the process, says Naik. When it is added to new concrete as an aggregate, the hardened pieces improve the strength of the new material.

The center is now trying to quantify the extent of concrete's CO_2-trapping abilities and recycling concrete from demolition to sequester CO_2 will soon be a usable technology, he says.

It's just in time. The cement issue is growing in urgency nationwide. Only 7% of the world's production of atmospheric carbon dioxide comes from making cement. But that translates into the release of more than 1.2 billion tons of CO_2 each year, says Naik. A quarter of all greenhouse gases produced in the world is generated by the U.S., but other populous countries, such as China and India, are close behind. With modernization accelerating in those countries, that amount is expected to boom in the coming years.

The use of fly ash and other by-products in shotcrete makes a contribution to the reduction in greenhouse gases and takes pressure off landfills while helping to improve the in-place performance of shotcrete.