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UWM Center for By-Products Utilization Wins EPA Award for Green Research in Concrete

MILWAUKEE – Can the concrete that encrusts the world's urban areas be a significant cause of global warming? According to Tarun Naik, a UWM civil engineering professor, there's a direct link between the two.

The production of one ton of cement, says Naik, creates approximately an equal amount of greenhouse gases. And you can't make concrete without cement: It's the "glue" that binds sand and stones together.

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 wasteproduct of coal-burning power plants that usually ends up in landfills.

Members of the Center for By-Products Utilization, Rudi Kraus (from left), Yoon-moon Chun and Tarun Naik display some concrete samples containing recycled materials.

Photos by Alan Magayne -Roshak

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 (C2P2) for its investigation into other uses for coal combustion products, like fly ash and other by-products generated by coal-burning power plants.

UWM's center has an international reputation for innovative research in this field. During the last year, it has worked on five different sponsored projects on the benefits of coal combustion products in concrete.

"By using fly ash in place of cement, we cut the corresponding amount of CO2 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.

To improve the microstructure and long-term strength of concrete that contains fly ash, two different chemical reactions need to happen, says Rudi Kraus, assistant director of the center.

"Some of our research has been on enhancing and accelerating these reactions through the use of activators," says Kraus. "The challenge to using it in concrete is in predicting the behavior of the fly ash."

The source of coal, type of boiler used to burn the coal, and ash collection process – if other types of emission reduction systems are used – all affect the fly ash.

"It has been a holy grail to use 100 percent fly ash," says Naik. "We have had successes with this idea in lab-produced concrete. However, it has not yet been implemented in real world practice."

In Wisconsin, the center has worked with We Energies to boost the amount of fly ash made available to industry for cement production. During its 24-year association with the center, We Energies has increased its sale of fly ash from 5 percent to 100 percent. In recent years, the power company also has 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 CO2 in the atmosphere, a chemical reaction will cause the softer lime particles in the concrete to harden, sequestering the CO2 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 CO2-trapping abilities and recycling concrete from demolition to sequester CO2 will soon be usable technology, he says.

It’s just in time. The cement issue is growing in urgency nationwide. Only 7 percent 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 CO2 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.

And with modernization accelerating in those countries, that amount is expected to boom in the coming years.

Naik says the time is ripe to offer industry alternatives.

Through the C2P2 program, the EPA and its co-sponsors partner with government and industry to reduce or eliminate barriers to the beneficial use of coal combustion products. The EPA aims to decrease greenhouse gas emissions from cement manufacturing by about 5 million tons by 2011.

More information about the center is available at http://www.cbu.uwm.edu.

For information on a multidisciplinary group of UWM researchers studying solutions to global warming, click here.

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