Why not recycled concrete?

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From paper towels to cups to plastic bottles, products made from recycled materials permeate our lives. One notable exception is building materials. Why can't we recycle concrete from our deteriorating infrastructure for use as material in new buildings and bridges? It's a question that a team of researchers at the University of Notre Dame is examining.

"While concrete is the most commonly used construction material on earth, it is also the biggest in terms of environmental impact," said Yahya "Gino" Kurama, a professor of civil and environmental engineering and earth sciences, who is leading the research effort. "Coarse aggregates, such as crushed rock and gravel, make up most of a given concrete volume. The mining, processing and transportation

operations for these aggregates consume large amounts of energy and adversely affect the ecology of forested areas and riverbeds."

A recent paper by a team of researchers in the journal *Science* questioned whether humans' combined environmental impact has caused the planet to enter a new geological epoch, the "Anthropocene." The scientists note the problem of concrete in particular, pointing out that more than half of the concrete ever used was produced in the past 20 years.

"Through my research, I want to contribute to efforts towards reducing these demands on our natural environment by reducing the need for natural coarse aggregates," Kurama said. "Especially in the years to come, the renovation and replacement of our nation's aging infrastructure will result in both an increase in the supply of old concrete rubble and the demand for new concrete. We need to be better prepared to utilize this growing resource at a higher level, which is what my research is focused on."

The biggest barrier to using recycled concrete has been the variability and uncertainty in the quality and properties of the recycled material and how this variability affects the strength, stiffness and durability of reinforced concrete structures. Kurama's team is trying to develop an understanding of how using recycled concrete affects the behavior of reinforced concrete structures so that buildings using large amounts of recycled material can be designed for safety and to serve their intended purpose without undesirable consequences in performance.

"Much of the research to date and the state-of-practice pertaining to sustainable use of structural concrete has focused on the partial replacement of cement with industrial byproducts, such as fly ash, slag and silica fume," Kurama said. "In comparison, conservation of coarse aggregates has been largely ignored in the U.S., resulting in a big knowledge gap related to this material."

Kurama's research group was the first to investigate recycled materials from a large number of sources, thereby studying the inherent variability in material quality and properties. Their research also addressed the deflection behavior, or how much a structure would continue to deform, over a long period of use under normal day-to-day loading and environmental conditions for the first time, as well as potential for using recycled aggregates in the precast concrete industry.

"Our initial research studied the variability from 16 recycled aggregate sources in the Midwest and quantified ways to pre-qualify the material for structural applications," Kurama said. "Through a partnership with the University of Texas at Tyler and New Mexico State University, we are now expanding this study to many more sources from the eastern, southern, and southwestern U.S. We are also looking at durability and life-cycle cost, in comparison with natural aggregates, and effects of recycled concrete aggregates in pre-stressed concrete. Because of the knowledge gap to date, the use of recycled aggregates in the U.S. has been limited mostly to non-structural applications such as sidewalks and roadways, even though the quality of the material is generally significantly higher than is required in these applications. Our ultimate goal is to develop the necessary engineering background and methods for the wider utilization of recycled concrete aggregates in structural concrete, such as in buildings."

Their results could be used by engineers to design concrete structures that incorporate varying amounts of recycled concrete aggregates that have less environmental impact than concrete structures made with natural aggregates.

Provided by University of Notre Dame

https://phys.org/news/2016-02-recycled-concrete.html