Cities of the Future Could Be Built With Concrete Made From Volcanic Ash

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Imagine concrete buildings filled with volcanic ash—ash that's embedded into the walls making them stronger and more environmentally friendly. That's what a team of international scientists sees in future cities based on research analyzing a unique concrete material made from volcanic ash and traditional cement. The new concrete could also reduce energy costs during concrete production, and some mixes are stronger than traditional cement.

Scientists from Massachusetts Institute of Technology, Kuwait Institute for Scientific Research and Kuwait University created a material that mixes pulverized volcanic rock with traditional cement. The material, based on calculations published online this week in the *Journal of Cleaner Production,* would take 16 percent less energy to construct a neighborhood of 26 concrete buildings, for instance. That specific energy reduction was found in a material made with 50 percent volcanic ash and 50 percent traditional cement—technically called Portland cement.

"When they make the Portland cement, it goes through so many different processes—from limestone collection, to grinding, to treatment, and then finally production," Kunal Kupwade-Patil, first author and research scientist in concrete durability and alternative cementitious materials. "It's a very high energy intensive process … But in the case of volcanic rock, it's just collection of the volcanic rock and grinding it into ash—that's it." Portland cement accounts for about 5 percent of the world's carbon dioxide emissions, according to the researchers. The heat required for its production is where much of its energy use originates.

Researchers tested various volcanic ash and cement mixtures with different percentages of each component. Examining the relationship between ash size, energy use to produce the materials and ratio between cement and volcanic ash revealed how the material itself was customizable. For instance, the tinier the ash was broken down, the stronger the concrete was.

"Volcanic ash may come in different forms," Oral Büyükoztürk, senior author and civil and environmental engineering professor at MIT, told *Newsweek*. "There is no uniformity. Obviously, an effort is required to grind them to a level that can be used in the mixture." But, that grinding process for volcanic ash doesn't require heat in the way that producing Portland cement does—which is where much of the energy use comes from.

Tinkering with the various elements of the mixture could lead to concrete specifically for different types of structures. For instance, tall buildings need stronger concrete, so the mixture might have tinier pieces of volcanic ash and a higher percentage of it. For traffic blocks, foundations and walls, larger pieces of ash could be mixed in with the cement since the density and strength isn't as imperative.

"There's a benefit of grinding because the finer the size, it becomes easier to react with the Portland cement," Kupwade-Patil said. That's the "chemical aspect as to why we need to grind it to a finer size."

The added benefits of volcanic ash is as a way to use up what is often a waste material for communities. Sourcing it locally eliminates the need for faraway transportation of materials as well, according to researchers. The volcanic ash these researchers focused on was from Kuwait's neighboring country, Saudi Arabia. Future research on volcanic ash concrete mixtures, said Kupwade-Patil, would have to examine how volcanic ash elsewhere would react with Portland cement since volcanic ash has varying properties depending on the location. Büyükoztürk imagines volcanic ash concrete mix on the city scale—drastically increasing energy savings.

"Imagine this energy saving at the material level from the laboratory to a building scale and from the building scale to the city scale," he said. "There may be a tremendous implication of energy savings at the city scale."