Grancrete™ Spray-On Structural Cement and Rapid Construction Process for Low-Cost Housing

Argonne National Laboratory

The United Nations estimates there are almost a billion poor people in the world, of whom 750 million live in urban areas without adequate shelter and basic services. But scientists at Argonne National Laboratory and Casa Grande LLC are developing a promising new technology that may lead to affordable housing for the world's poorest. A tough new ceramic material that is almost twice as strong as concrete may be the key to providing high-quality, low-cost housing throughout developing nations.

The ceramic is called Grancrete, which, when sprayed onto a rudimentary Styrofoam frame, dries to form a lightweight but durable surface. The resulting house is a major upgrade to the fragile structures in which millions of the world's poorest currently live. As a result, Grancrete was recognized with an R&D 100 Award from *R&D Magazine* as one of the "most technologically significant new products" of 2004.

Grancrete was developed by the firm Casa Grande in conjunction with Argonne National Laboratory. Argonne scientists originally designed Ceramicrete, a slightly different cement-like material, in 1996 to encase nuclear waste. The resilient Ceramicrete permanently prevents hazardous and radioactive contaminants from leaching into the environment. At the same time, Casa Grande president Jim Paul was traveling throughout South America, observing the inadequate housing in poorer neighborhoods.

"Originally Casa Grande was looking for a concrete substitute for American industry, because concrete erodes in acidic conditions," says Mr. Paul. "But as I was traveling in Venezuela, I recognized the demand for cheap housing, and I thought about how to use our material for that."

Casa Grande was still perfecting its concrete substitute, but its material, when dry, occasionally cracked. So Paul partnered with researcher Arun Wagh, a staff ceramist at Argonne, to combine their technologies. Together they developed Grancrete.

According to experiments, Grancrete is stronger than concrete, is fire resistant and can withstand both tropical and sub-freezing temperatures, making it ideal for a broad range of geographical locations. It insulates so well that it keeps dwellings in arid regions cool, and those in frigid regions warm. Currently Grancrete is sprayed onto Styrofoam walls, to which it adheres and dries. The Styrofoam remains in place as an effective insulator, although Dr. Wagh suggests simpler walls, such as woven fiber mats, also work well and further reduce the raw materials required.

Using Grancrete in developing countries also allows for two important criteria, says Dr. Wagh.

"When you build houses in these poor villages, the materials you use should be indigenous, and the labor should be indigenous," he says. "Every village has soil and ash, and the labor and training requirements are so minimal that two local people can build a house in two days."

According to Mr. Paul, workers only need two days of training to learn how to control and calibrate the machinery. Casa Grande typically assembles a team of five people who can start in the morning and create a home that residents can move into that evening. The material cures within two to four hours, whereas concrete can take hours or days to dry.

Grancrete is made from an environmentally friendly mix of locally available chemicals.

"Grancrete is 50 percent sand or sandy soil, 25 percent ash and 25 percent binding material," Dr. Wagh says. Binding material is composed of magnesium oxide and potassium phosphate, the latter of which is a biodegradable element in fertilizer. So even if Grancrete were to decompose, he points out, it would revitalize the soil.

The cost of building a Grancrete home, estimated by Casa Grande at about $6,000US for labor and materials, is several times less expensive than a home built using conventional building materials. And the homes themselves are more than four simple walls. For less than $10,000US, laborers can produce Grancrete dwellings of 800 square feet; a typical apartment in a city like Bombay, India, is only 400 square feet.

Dr. Wagh's goal is to see Grancrete used throughout his native India and the world to produce housing for the poor. Born in the Indian state of Karnataka, Wagh grew up in a neighborhood where even to this day the homes have walls and ceilings made from knitted mats of palm leaves and the floors are made of dried cow dung.

"These homes are regularly subjected to hundreds of inches of monsoon rains and cyclone winds, and therefore often have to be repaired or even entirely rebuilt," says Dr. Wagh. "Obviously such conditions can have a great impact on the health, well-being, and longevity of the children and adults living there." The Grancrete spray-on cement now offers hundreds of millions of people such as these the opportunity to have adequate housing and live longer, healthier lives.

Argonne and Casa Grande have extensively field-tested Grancrete for structural properties, post-application behavior and production costs. According to Terry Maynard, manager of Argonne's technology transfer efforts for Grancrete, "the next step will be to test it for both earthquake and hurricane resistance, after which Argonne and Casa Grande will make the product available worldwide." Wagh hopes the United Nations and other international organizations will step forth and subsidize mass-scale production around the world.

In short, Grancrete provides the opportunity to produce dwellings that are adequate for families in almost any city in any developing nation. It is inexpensive, environment-friendly and structurally superior to current housing options. In fact, a skeptic might question whether Grancrete is too good to be true.

"Believe it," says Dr. Wagh genially. "It's not magic – all we're doing is making a better cement."

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For additional information contact the Office of Technology Transfer, Terry Maynard, 630-252-9771, tmaynard@anl.gov, or Jim Paul, Grancrete, 804-730-0023, j.paul@grancrete/net. www.grancrete.net.

1. The shell of the building is constructed using expandable polystyrene (EPS) foam panels, such as Styrofoam-brand EPS panels, which are held in place using lightweight aluminum channels anchored to the foundation.

2. Lightweight aluminum channels also are used at the corners and between every 4-foot by 8-foot panel to hold them in position during spraying. From start to finish, all of the foam panels for the walls and roof can be installed and ready to be covered by Grancrete cement in just a few hours.

3. The roof is also constructed of foam panels that are held in place by aluminum channels. Once covered with Grancrete, the roof becomes an integral, water-tight part of the home.

4. The window and door openings are cut out of the foam, and the frames installed. Conduit and pipes for electrical and plumbing utilities can be attached to the foam and then sprayed over with Grancrete to conceal and protect them.

5. Both the exterior and interior of the walls and roof are sprayed to a thickness of about one-half inch. Grancrete is sprayed around the windows and door frames to ensure a weather-proof seal.

6. A few hours later the Grancrete has hardened and is ready to be occupied.