Precast Concrete Farmhouse

Dan Chiles is a solar power visionary. Not content to merely capture heat in solar roof panels, he conceived a sustainable solar hydronic radiant heating and cooling system that taps into the thermal properties of precast concrete. The system works by capturing and storing energy inside of precast concrete panels using hybrid cross-linked polyethylene (PEX) tubing, and transferring the heat between the faces to adjust the building’s internal temperature.

To test his theory he designed a house, called Rockspan, for his own property in Greene County, Mo., that would be made entirely of precast concrete panels. But when he brought the idea to locally based Prestressed Casting Co., they were skeptical.

“We weren’t interested at first, but once he presented his ideas for the heating and cooling system we were intrigued,” says Dave Robertson, LEED AP BD&C, sales manager for Prestressed Casting.

Robertson knew that the panels themselves would be easy to craft. The challenge lay in how to automate the process of embedding the tubing and technology into the panels and ensuring that connections could easily be made between them, he says. They also needed the panel design to fit into Chiles’s relatively limited budget.
It took a lot of conversations, he says. “We spent more time talking, sketching, and refining than we did in the plant.”

After two years of planning, the panels were made and the house was assembled in late December of 2012. Erection took just a day and a half.

**Three levels, ten panels, two miles of tubing**

The three-story building has a 20 × 40 ft (6 × 12 m) footprint made of ten 10 ft wide × 37 ft (3 × 11 m) tall precast concrete panels. Each wall section is made of a 3 in. (75 mm) thick outer concrete wythe, a polyisocyanurate insulation core, and a 3 in. inner concrete wythe for a total thickness of 10 in. (250 mm). The panels are structurally reinforced with prestressed steel cables, reinforcing bars, and mesh, which help make the house tornado resistant, an important goal for Chiles.

“We have storms that can snap a walnut tree in half,” he says, “and those don’t even make the news.”

The real innovation is inside the panels. Both inner and outer wythes contain 2 mi (3.2 km) of PEX heat exchange tubing to collect, transfer, and emit energy. The walls operate as a coordinated system to absorb and radiate energy both inside and outside the building envelope. Internal temperature is monitored by 72 sensors embedded in the walls that track conditions and compare those readings with data from pipe-mounted meters in the home. “If sensors show it’s hot in the house, the system absorbs heat and moves it out,” Chiles says. “If it’s cold, a small heat pump brings energy back into the inside walls.”

**Industrial gray, thinking green**

The look and feel of the house is surprisingly simple and stark. The panels are a smooth industrial gray, broken up by several large windows and wood accents. “We looked at a lot of different colors, textures, and even sandblasting,” Robertson says.

In the end, he says, they decided that the dark gray would be the best energy-absorbing surface, and was the most economical choice. “We wanted to put dollars where they would have the most impact.”

Chiles is now testing the technology and collecting data about how it functions over the course of four seasons. He’s also applying for sustainability certifications. The house has already received an Energy Star rating of -12—a rating of zero means the house produces as much energy as it uses—and it has met the Department of Energy Challenge Home criteria for excellence and quality. Chiles is currently pursuing LEED certification for sustainable home construction.

Ultimately, Chiles hopes to replicate the system for commercial projects, and Robertson says he is optimistic about the possibilities. “This is a brand new innovative way to heat and cool a structure,” Robertson says. “It could completely replace an HVAC system in the right environment.”

—Sarah Fister Gale
Welcome to the Forever Home

In the weeks following Hurricane Katrina, the engineers at Spancrete came up with an innovative idea: design an entirely precast concrete house that looks like a charming cottage but can withstand extreme weather like a concrete bunker.

“Precast concrete is a great material to meet hurricane code requirements, which makes it very attractive for devastated weather areas,” says John Nagy, owner of Spancrete, which is based in Waukesha, Wis.

The idea was to create an economical, sustainable design that could be duplicated quickly on a large scale so that communities hit by natural disasters could rapidly rebuild.

“We anticipated that it would take a year to develop the product and bring it to market,” Nagy says. He was half right.

Cottage styling feels like home

Within a year, Clinton Krell, the lead engineer on the project, designed the Forever Home, a 1200 ft² (110 m²), three-bedroom, two-bath cottage made entirely out of precast concrete panels. Each house features eight sandwich insulated wall panels, hollow-core floors, precast concrete beams to support the walls, and five 30 ft (9 m) wide insulated concrete roof panels.

“Accommodating the different site conditions was the biggest challenge of the project,” Krell says.

He overcame it by designing the house to be elevated above local flood levels using precast concrete columns anchored to beams set underground.

The resulting home can withstand 170 mph (270 kph) winds, dynamic forces caused by floods, and the impact from debris during catastrophic events.

To make the homes appealing to residential customers, Spancrete customized the forms to accommodate a variety of architectural features, including a metal rib-patterned roof surface, gutters, clapboard siding, and wood and brick accents. “Using formliners and different mediums, every home can be unique,” Nagy says.

Spancrete partnered with industry vendors to include internal amenities as well, including lighting, windows, HVAC, and plumbing.

“We have all the relationships to create a turnkey solution.”

The Forever Home cottage can be erected in two days, and because the windows and doors are cast directly into the wall panels, the house can be securely locked down the moment erection is complete, Krell says.

Finding a buyer

The concrete cottage is the perfect solution for hard-hit communities trying to rebuild after disaster like hurricanes Katrina and Sandy, and many government agencies have shown interest in the design. They are drawn to the design because it is cost competitive compared with stick-built homes and is energy efficient. In addition, it can be insured in many communities where other construction styles cannot because it is designed to withstand hurricane-force winds, Nagy says.

Unfortunately, there has been so little government money released to help rebuild these communities that the Forever Home concept has yet to be rolled out on a grand scale. Nagy is in negotiations with a number of developers and government agencies interested in doing large-scale home building projects.

“The cost of rebuilding after these storms is unbelievable,” Nagy says. “We want to make sure that when they do rebuild, that destruction doesn’t happen again.”

—Sarah Fister Gale

Insulated precast concrete panels form the walls and roof of Spancrete’s Forever Home. The cottage-style home was designed with disaster resistance in mind after Hurricane Katrina. Courtesy of Spancrete.