Walls Get Smarter With Precast Concrete

Space-efficient telescopic precast concrete walls keep floodwaters at bay.

By Shari Held

Photo courtesy of University at Buffalo

The extremely tight tolerances afforded by precast concrete make the Smart Walls system possible.

Today, Jorge Cueto holds a doctorate in civil engineering, owns an award-winning, patented innovation and is the founder of Smart Walls Construction LLC in Amherst, N.Y. He's also earned a $225,000 Small Business Innovation Research grant from the National Science Foundation and the University at Buffalo's School of Engineering and Applied Sciences Outstanding Young Alumnus Award.

But just six years ago, Cueto was in a very different situation. While his consulting/construction business in Bogotá, Colombia, was successful, he and his business partner were faced with shrinking profit margins.

"The problem was we weren't doing anything new," Cueto said. "The only way we could compete was to drop our prices. That creates a non-sustainable business model."

In pursuit of change, he applied for and won a Fulbright Scholarship and headed to the University at Buffalo in 2011 to pursue his Ph.D. and acquire the additional knowledge needed to research and develop a novel idea.

EUREKA!

Cueto was playing around with an umbrella while working on an assignment when a groundbreaking idea hit him: He'd create a telescopic wall system for bridges and buildings. This initial idea more fully materialized a year later while he watched coverage of the one-year anniversary of Hurricane Sandy.

"As a civil engineer, you are taught to use your knowledge to help society," Cueto said. "I envisioned telescoping walls that could be raised when needed and retracted after the danger of floodwaters has gone."

Another plus with a telescopic wall system is it boasts potential for commercialization.

"Smart Walls addresses a national need for flood control and the system shows promise," said Dr. Amjad Aref, a professor in the civil engineering department at the University at Buffalo and one of Cueto's academic advisors. "The fact that it's an on-demand product sets it apart from anything else."

PRECAST: THE ONLY SOLUTION

Making his concept a reality was the next step. Concrete was always Cueto's top choice for his Smart Walls system. Besides corrosion and other drawbacks, metal was too expensive, and one of Cueto's goals was to keep the product affordable to provide protection for more people. In addition, the components need to be precise.

"If there's one thing these walls need, it's precision," Cueto said. "They nest inside each other. If the tolerances are off, the

When deployed, each of the wall sections telescopes into the next, creating a barrier

system won't work. The only way you can achieve those tight tolerances is with precast."

Cueto's next consideration was choosing the best concrete. The wall system needed to be resilient enough to withstand the impact of coastal waves. Using traditional steel rebar-reinforced concrete would make the wall sections too thick and too heavy to handle. Ultimately, fiber-reinforced ultra high performance concrete proved to be the answer for the hollow boxes Cueto envisioned for Smart Walls.

"One of Jorge's goals was to make the fabricated pieces as thin as possible while remaining very durable and resistant to abrasion due to water impact and erosion," said Gregory Nault, P.E., S.E., a UHPC specialist for structural engineering applications for Ductal at LafargeHolcim.

UHPC is reinforced with metal fibers and exhibits a structural strength up to 10 times higher than traditional concrete. It doesn't break under pressure and its service life can reach two to three times longer than traditional concrete. Any cracks that form are infinitesimal, so the concrete isn't likely to sustain any water damage.

"The material quite honestly can last hundreds of years with zero maintenance required," Nault said.

A CUSTOMIZABLE APPROACH

The Smart Walls system is housed in a foundation or base box that remains underground and holds the hollow, rectangular wall sections. The width of the base box is 18 inches, with each box smaller in width and length than the one below it. When deployed, the wall sections telescope into one another to create a barrier.

Once installed, the Smart Walls system is virtually invisible, allowing unobstructed views when not in use. Smart Walls can be raised during threatening weather conditions and lowered once the danger is over and storm waters recede. This innovative solution takes stormwater protection to another level.

Another key feature of the Smart Walls system is it's customizable to fit the sizing needs of any project. Taller, more expansive barriers can help cities escape damage from hurricanes, while a 2-foot-high barrier can protect a homeowner's property from 12 inches of floodwater.

"One foot of floodwater is just enough to make your life miserable," Cueto said. "The beauty of this technology is that it allows customers to say what they need."

A manual system works best in situations where there are a limited number of walls that rise only two or three feet above ground. The walls are light enough that two people could raise

them in a timely manner. A Smart Walls system comprised of taller sections or a substantial number of sections can be raised by a crane. The system can also be fully automated so that it rises and lowers with the touch of a button and can be retrofitted with automation at any time.

Although Cueto had developed a gasket to keep Smart Walls watertight, when the walls are raised, 6-inch gaps are created between the boxes and adjacent walls. To close the gaps between boxes, the automated version is designed with hinged flaps that extend laterally as the wall system rises. For the manual version, the solution is to slide metal plates between the walls.

Depending on the tidal force, the gaps may not need to be covered at all.

"We're not building a swimming pool," Cueto said. "When we use telescoping walls for coastal storm surges, the wall breaks the wave and stops the water from going to the other side. A 6-inch gap won't make that much difference."

PUTTING IT TO THE TEST

"With software technologies, you can go back into production and then issue an update," Cueto said. "As civil engineers, we don't have that luxury. We need to do a lot of development and testing with structural systems because people's lives are at stake."

As part of the requirements for fulfilling the NFS grant, Cueto had to prove the technical feasibility of his Smart Walls concept. To do that, he created a prototype consisting of deployable boxes that measured 18 inches wide, 3 feet long and 3 feet above ground. Each Smart Walls section in the prototype weighed approximately 250 pounds. Four straight Smart Walls and four curved Smart Walls were used in the enclosure prototype.

In June, the Hinsdale Wave Research Laboratory at Oregon State University conducted a series of tests on Cueto's prototype to determine the effectiveness of the flaps, plates and gaskets. It was a technical success.

Next, researchers tested the individual walls. They applied tsunami-force waves to determine what it would take to make the walls break. All but one held firm. The curved walls withstood the tsunami waves better than the straight walls.

"That's when we first realized Smart Walls could be used against tsunamis," Cueto said. "I'm so excited about this new use."


Photo courtesy of University at Buffalo

GOING COMMERCIAL

Now Cueto faces a challenge bigger than any of the technical hurdles he's overcome so far. To successfully take Smart Walls to the commercial market, he must persuade people to accept a revolutionary concept. That's tough at any time, but especially when the product involves public safety.

Cueto's target market is coastal cities in need of storm surge protection.

"Our whole Smart Walls system is in pursuit of increasing the resiliency of cities so they can withstand the natural hazards of storm surges or floods without even stopping their operations," Cueto said.

So far, he's seen interest from municipalities nationwide, including Gowanda and Buffalo, N.Y.; Miami/Dade County, Fla.; Tulsa, Okla.; Fort Worth, Texas; Norfolk, Va.; Boston, Mass.; Pittsburgh, Pa.; and Keansburg, N.J.

But the ultimate test doesn't lie within the confines of a lab. Currently, Cueto is searching for a pilot project or two, talking to the resiliency offices and other entities in New York City, Houston and Newport, Ore. He's also been invited to make a presentation to the Army Corps of Engineers. He hopes to have a pilot project completed within the next two years.

"That is the best validation of the momentum that Smart Walls is picking up," Cueto said. "It will be up to the team to capitalize on all these opportunities and deliver the best technology for flood protection." PS

Shari Held is an Indianapolis, Ind.-based freelance writer who has covered the construction industry for more than 10 years.

While lab tests have been successful, Cueto's goal is to secure pilot projects for the system.

Photo courtesy of Smart Walls LLC