

Brooklyn redevelopment uses 3-D mold printing for window panels

In early 2018, Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tenn., and Gate Precast Co. in Winchester, Ky., opened their facilities to 13 PCI members and staff to see firsthand what could be the future of precast concrete molds: a three-dimensional (3-D) printing and machining operation.

PCI has been working with ORNL on enclosure research with the U.S. Department of Energy. One part of the enclosure project involves 3-D printing molds in order to reduce forming costs and address the potential lack of skilled carpenters.

During the first year of the research project, a 1 ft (300 mm) long section of a complicated cornice was printed using 3-D technology and more than 30 casts were made in the mold without degradation. During the second year, when ORNL was looking for a larger project on which to test 3-D printing capabilities, Gate Precast stepped forward with precast concrete punched window panels for the 42-story 260 Kent Avenue portion of the Domino Sugar Refinery redevelopment project in Brooklyn, N.Y. As a result, after only a year and a half, the 3-D form printing process was able to progress from concept to commercialization.

“Oak Ridge National Laboratory is well-known for its R&D work in 3-D printing capabilities,” says Diana E. Hun, sub-program manager for building envelopes at ORNL. “During some interactions with PCI, we found out that the precast industry is short on certain types of skilled labor, which led us to think about opportunities for 3-D printing in that industry.”

As ORNL began looking at opportunities for 3-D mold printing for the precast concrete industry, however, some challenges arose, most of which resulted from the fact that, initially, ORNL didn’t have any experience trying to cast concrete in a 3-D–printed mold. “One challenge was that we didn’t know how the concrete would interact with the material we were using with the molds,” Hun says. “We also didn’t know the best material to use to ensure cost-effectiveness as well as durability.”

Although it took some time, the issue of durability was successfully addressed. “Initially, we thought that the process might be too expensive,” Hun says. “However, when we began working with Gate Precast, we found that these molds can last for a large number of pours with limited degradation, and they remain highly durable. And, of course, the

more pours you are able to get, the cheaper the mold itself becomes.”

The 3-D–printed molds are also cost-effective because of the level of complexity that is possible. “If you want something simple, you can do it with plywood,” Hun says. “However, if there is a mold that requires hiring a sculptor or something that has a very elaborate reveal, that will take a long time to do by hand and will end up being very expensive.”

Gate Precast got involved in part to try to address a workforce challenge. “In our industry, there are not as many craftsmen as there once were who are interested in building ornate molds,” says Steve Brock, senior vice president of engineering for Gate Precast. “As a result, we have labor shortages in this area.”



This rendering shows the Domino Sugar Refinery redevelopment project in Brooklyn, N.Y. Gate Precast Co. teamed up with Oak Ridge National Laboratory to create the forms for the window panels in the 42-story, mixed-use 260 Kent Avenue structure—the tallest building in the project—using 3-D printing. Rendering by COOKFOX Architects.



Brock happened to be a member of a PCI research and development council advisory group when he heard about the work that ORNL was doing with 3-D printing. “As a result, we began working with them,” he says. “At first, we used 3-D printing for a one-foot-wide cornice to show the concept, and ORNL then asked us for another project that would allow the concept to be scaled up.”

Around this time, Gate Precast was beginning work on the Domino Sugar Refinery redevelopment project, which would

A window panel form for the Domino Sugar Refinery redevelopment project in Brooklyn, N.Y., is being 3-D printed at AES in Akron, Ohio.
Photo courtesy of Gate Precast Marketing.

require a lot more mold work than Gate Precast would be able to do in its plant. “As a result, we proposed this project to Oak Ridge as a candidate for the scale-up,” he says. The project involves redeveloping the historic waterfront Domino Sugar Refinery to include apartments, retail, and office space.

As of mid-October 2018, facade installation is under-way and the superstructure has reached the twelfth floor. “Installation at the Domino site is just getting started this fall and should continue for several months,” Brock says.


To date, all parties are happy with the progress. “We were basically inventing something from scratch,” he says. “However, we were able to go from a small 1 ft sample to making hundreds of pieces for a very large project in a very short amount of time.”

Brock says that 3-D mold printing can be cost-effective in a number of situations: highly repetitive, relatively simple shapes where the expense of steel forms cannot be justified; complex forms where the need for repetition is higher than what a pre-caster would normally get from wood molds; and highly ornate shapes where a pre-caster cannot afford to tie up master mold builders for minimal concrete volumes.

In addition, the technology provides crisper edges, allows for better vibration to consolidate the concrete (thus leaving minimal bugholes in the finished concrete and requiring less repair work), and is better suited to today’s younger tech-savvy workforce because 3-D printers require programming.

“Everyone who is involved in this technology believes that it will continue to be optimized, making it even less expensive in the future than it is now,” Brock says. “The less expensive it becomes, of course, the more applications where it will make sense.”

In addition, as the shortage of skilled laborers who are interested in building complex molds increases and as the requirements coming from architectural firms continue to become more complex, Brock says he thinks that 3-D mold printing might eventually become a necessity.

—William Atkinson 



Window panels for the Domino Sugar Refinery redevelopment project in Brooklyn, N.Y., are stored at Gate Precast in Winchester, Ky. The panels were made using forms that were created with 3-D printing.
Courtesy of ORNL.