Field Report
Circular Construction
By Paul Hockenos

Stanford Social Innovation Review
Summer 2024

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Circular Construction

A multinational team is upcycling old concrete and brick for new buildings in the Czech Republic.

BY PAUL HOCKENOS

butting the Vltava River’s muddy bank on the outskirts of Prague, three new apartment buildings contain a potential breakthrough in sustainable architecture. With help from the European Union and other partners, the multinational construction and development company Skanska has developed an industrial-quality, hybrid concrete by upcycling concrete and masonry rubble. Skanska and Czech architects are employing this “green concrete”—which Skanska patented under the name Rebetong in 2019—for the apartment buildings’ internal walls, foundations, façades, and pavements using the concrete from the ruins of an early-20th-century sugar factory that once stood on the site.

The Prague- and London-based architecture firm CHYBIK + KRISTOF designed the blueprint for the new building complex, called the Sugar Factory estate. According to the firm’s founder, Michal Kristof, the estate will eventually accommodate seven buildings with a total of 790 apartments, in addition to an event space, brewery, and kindergarten. Each successive new building will comprise a greater percentage of Rebetong than the three preliminary apartment buildings. All buildings in the complex will draw energy from rooftop solar panels and utilize recycled water. Residents will move into the first of the finished apartment buildings later this year.

Circ-Boost, the EU’s arm to fund research and innovation, has contributed approximately $400,000 to defray building costs associated with piloting the Sugar Factory project’s sustainability innovations over the next four years. The project is one of several across Europe that are part of the $8 million Circ-Boost initiative to promote circular solutions in construction value chains across Europe. The Sugar Factory estate and Circ-Boost’s four other pilots will demonstrate novel circular solutions for residential-building construction, construction-waste processing, and emissions reduction.

“Our intention is to demonstrate the use of new technology in the real environment,” says Circ-Boost project head Albert de la Fuente Antequera, a civil engineer at Polytechnic University of Catalonia.

The motivation to address sustainability in the construction industry stems from its staggering discharge of greenhouse gases and consumption of natural resources. Concrete alone generates 9 percent of all human-generated CO₂ emissions. The industry is responsible for 40 percent of global emissions, and it consumes nearly half of the roughly 50 million metric tons of crushed rock, gravel, and sand extracted from the earth every year. Moreover, the construction industry generates 30 percent of the planet’s waste.

The world’s nations must contend with the construction sector if they intend to meet climate and other environmental targets, especially considering that “there’s going to be a lot more construction happening in Europe,” says José Mercado of the German Energy Agency (DENA), a Berlin-based clean-energy institute. In fact, the sector’s use of raw materials is expected to double over the next two decades.

Mercado says that the drive to create sustainable concrete is hugely important and resembles other experimentations in the field of sustainable construction in which the private sector, research institutes, nations, and the European Union collaborate. The diverse partnerships of the Sugar Factory estate illustrate exactly how this kind of collaboration can work and yield results that no one actor or even a smaller cooperative could produce on its own.
A DURABLE REPLACEMENT

Recycling and reusing concrete and brick are not new ideas; they have long been deployed, including in highway pavement. But recycled concrete had long lacked the quality of the high-grade variant produced with virgin materials that developers favor for buildings. The drawback had been that this kind of mixed-material recycled concrete was less durable and flexible than standard concrete. Its life span was about half as long (roughly 30 years), and moisture penetrated it at a rate higher than traditional concrete, causing it to crack.

However, Rebetong, says Skanska’s Bohuslav Slánský, one of its creators, is in another league. “Tests show that even with very high proportions of recycled materials, up to 100 percent, the final concrete mixture exhibits a similar performance to conventional concrete,” he says.

The difference between Rebetong and its predecessors is that the former is made with a nano-additive created by the now-defunct Czech-based firm ERC-TECH. In 2018, ERC-TECH approached Skanska with a chemical substance of very fine granularity that in limited testing had shown an impressive ability, when mixed with cement, to bind recycled masonry into a concrete with impressive levels of durability. Skanska purchased the nano-additive—with the help of a 2 million Czech koruna ($90,000) grant from the Czech Republic’s ministry for industry—and further developed it.

Skanska’s headquarters in Sweden heralds Rebetong as a “concrete that uses one hundred percent recycled concrete and/or masonry to fully replace natural aggregates. This circular approach enables new buildings to be constructed from other buildings at the end of their life cycle.” In its 2019 sustainability report, Skanska also claims that Rebetong’s production emits 12 percent fewer carbon emissions—mostly from reduced transportation costs—and exhibits greater heat retention, adding another perk that enhances buildings’ energy efficiency.

De la Fuente Antequera expects Rebetong to become a fully functional concrete with 100 percent recycled material that can be produced cheaply with much the same hardware as traditional concrete. Once the results are verified by the Czech Technical University in Prague (CTU) laboratories, Circ-Boost project officials plan to disseminate the findings to hundreds of other construction and development companies across Europe and beyond. They hope that these companies will ultimately adopt similar circular solutions, particularly concrete mixes using upcycled materials like Rebetong.

GETTING TO 100 PERCENT

But the Rebetong employed in the Czech projects isn’t fully circular yet. It currently exists in different grades, and the mixes with lower quantities of recycled materials can be deployed more widely than in building elements that require more elasticity. The first Sugar Factory estate structures containing Rebetong relied on 25 to 50 percent recycled materials. In CTU laboratories, even higher grades have been tested with positive results. This year, the Sugar Factory developers will employ Rebetong with 50 to 75 percent of recycled aggregate.

While the onsite application of Rebetong at the Sugar Factory estate has delivered results very much like those of traditional concrete, Skanska discovered that it hardened more slowly than conventional concrete in cold weather, which slowed construction during the 2022-23 winter season. Since this discovery, Skanska says that it tweaked the recipe to produce a mix that now hardens at the same rate as conventional concrete.

Another challenge is the dearth of high-quality demolition rubble necessary to produce Rebetong. Decaying demolition-site debris that often ends up in mixed-material landfills has limited upcycling value. For example, because of the poor quality of the old bricks from the sugar factory, only a minimal percentage of them could be incorporated into the Rebetong used for the housing complex.

In order for green-concrete production—and circular construction in general—to function, demolitions have to follow certain procedures, like meticulously sorting waste according to type and then sending it to recycling centers or commercial buyers, rather than to landfill sites. Demolitions themselves have to happen much differently than they do today, in a way that enables the collection of potentially valuable debris. More recycling centers and markets for used construction materials, Mercado says, are critical to realizing Europe’s vision for a circular economy.

Despite its breakthrough qualities, Rebetong will most likely face skepticism on the construction-materials market. “The construction industry’s emissions and resource use are so egregious that every step forward in sustainability can result in significant gains,” Mercado explains. In Europe, he says, the construction sector is transitioning to a circular economy slowly, even though it is central to EU climate-protection plans.

One of the biggest obstacles, Mercado observes, is that the construction industry is very conservative and sticks with what it knows. “The greatest hurdle,” he says, “is getting everybody on board to think about construction in a completely new way.”

Skanska’s next step is to increase the quantity of recycled concrete in Rebetong and complete the Sugar Factory project, and then move on to other building projects in the Czech Republic. It intends to experiment more with alternative cement mixes as well, which will lower the carbon footprint of concrete even further.

De la Fuente Antequera’s team is watching closely, confident that concrete upcycling can help transform the global construction sector for the better. Hundreds of international construction companies are awaiting Circ-Boost’s results.

Upcycled materials like Rebetong will help to transform the global construction sector for the better.

PAUL HOCKENOS is a Berlin-based writer covering energy and climate issues. He is the author of five books on European affairs.