Low-Carbon Concrete

Using concrete that stores CO2 can significantly decrease global carbon emissions and make buildings stronger

(Photo courtesy of Zero Energy Project)

The Impact

Save for water, concrete is the most widely used material on Earth. Producing cement, the binding component of concrete, by burning limestone accounts for around 8 to 11% of global CO2 emissions. Low-carbon concrete has an immense potential for reducing this figure. For example, the construction of LinkedIn's campus in Mountain View, Calif., with low-carbon CarbonCure concrete sequestered 240,000 pounds of carbon from the atmosphere. When compared to traditional concrete, some low-carbon concrete is stronger, lighter, and longer lasting.

Description

It's important to understand that low-carbon concrete is not one specific product. Rather, it's any type of concrete that decreases the amount of CO2 in the atmosphere when used in place of normal concrete. Concrete can reduce CO2 emissions in a number of ways, such as by trapping carbon dioxide through its solid structure or being composed of materials other than combusted limestone. The overall goal is to find a method of concrete production that releases less CO2 than usual or, better yet, traps more CO2 than it took to create the concrete; this method results in what is specifically known as carbon negative concrete.

Various companies have created their own solutions to the problem of CO2 emissions from concrete production. Some of the most prominent companies in the low-carbon concrete market are CarbonCure Technologies, Blue Planet and Carbicrete. CarbonCure focuses on trapping the CO2 created in limestone combustion (a process known as sequestering) and injecting that same CO2 into

the concrete, which mineralizes and becomes sequestered in the structure of the concrete. In addition to strengthening the concrete, this process also traps the CO2 in a form that prevents it from entering the environment.

Instead of focusing on the carbon footprint of cement production, Blue Planet tackles the overall issue of CO2 produced by factories by collecting and converting it into CaCO3 (calcium carbonate/limestone), and using the synthetic limestone as a replacement for aggregate, the material that makes up 75% of concrete. On the other hand, Carbicrete avoids creating CO2 emissions entirely by recycling ground slag from steel production and decreases existing CO2 levels by curing concrete with CO2, embedding the gas into the concrete's structure. A carbicrete plant sequesters around 20,000 tons of carbon annually.

Where It's Been Implemented

Low-carbon concrete has been used in numerous structures around the country and the world. Some of the first low-carbon concrete buildings in the Bay Area were LinkedIn's Middlefield campus, built in 2021, and a new academic building for the University of California's Hastings College of the Law, built in 2019. Boarding Area B in Terminal 2 of San Francisco International Airport was built in 2011 from concrete containing carbon-sequestered aggregate, which reduced carbon concrete emissions by 48% and helped earn the terminal "gold" status in Leadership in Energy and Environmental Design (LEED).

California's Marin County adopted the world's first building code that limited carbon emissions from concrete in January 2020. Since then, states like New York, Texas, Hawaii, Ohio and New Jersey have approved policies mandating low-carbon concrete in construction. StopWaste provides information and templates for locally implementing Low Carbon Concrete code based on Marin County's code. C40 Cities provides additional information for general building decarbonization.

Key Drivers

Low-carbon concrete was produced to tackle the issue of climate change. One major source of greenhouse gas pollution is concrete production, as the limestone combustion process typically necessary to produce cement releases large amounts of carbon dioxide. In fact, since cement is such a high-demand material, the concrete industry is responsible for up to 11% of global CO2 emissions and, if it were a country, would be the third largest contributor of CO2 pollution in the world. Low-carbon concrete aims to counter the unsustainable practices of concrete production by not only creating concrete through less pollutive means but also by removing CO2 from the air and trapping it within concrete. This process, when repeated by companies on a large scale, can create serious reductions in global CO2 pollution and possibly play a great role in the reversal of climate change.

Key Factors for Success

Marin County benefited from funding by the Bay Area Air Quality Management District's Climate Protection Grant Program and the cooperation of local government leaders, engineers and academics. Other partners included the Carbon Leadership Forum, the U.S. Green Building Council (USGBC) and leaders from the concrete industry. Many case studies contributed to confidence in the quality of the concrete. It's also important for local citizens and companies to be educated on the benefits of low-carbon concrete to increase support and minimize opposition toward low-carbon concrete mandates.

Key Obstacles

Several drawbacks and obstacles exist for the implementation of low-carbon concrete. It is estimated that buildings made from low-carbon concrete cost 1% more to produce, which can be significantly more expensive for large structures. It also takes additional time and energy to cure concrete with CO2, and the energy used in curing needs to be renewable in order to not release substantial greenhouse gasses. Looking at the bigger picture, however, the advantages of low-carbon concrete far outweigh the disadvantages. Low-carbon concrete is structurally strengthened through the sequestering of CO2, it reduces the global carbon footprint and it promotes the usage of sustainable technology.

Timeline to Implementation

In general, the time to implement a plan such as this must include enough time to identify and consult with companies that provide the technologies and methodologies to decrease the carbon content of concrete, work with concrete manufacturers to create the desired product, and work with architects and engineers to best identify the structures a d areas where low-carbon concrete can be implemented.

Return on Investment

Low-carbon concrete has been proven to be effective in creating strong, durable structures. For around a 1% increase in price, consumers receive sustainable concrete strengthened with CO2, slag and/or other materials. There are no current reports of structures made from low-carbon concrete breaking down or facing stability issues. Low-carbon concrete structures have stayed sturdy and been recognized as sustainable, progressive buildings made with green technology. The reductions in CO2 emissions by the concrete industry from utilizing low-carbon concrete are also tremendous: CarbonCure, for example, reports that its technology sequestered more than 60 tons of CO2 during 2021. If the concrete industry, with a market size of around 4.15 billion metric tons annually, were to completely shift to low-carbon cement, 7.7 to 15.56 gigatons of carbon would be sequestered between 2020 to 2050.

Low-carbon concrete is a great option for companies and cities looking to meet their greenhouse gas reduction goals. Overall, there is a substantial return on investment for creating structures from low-carbon concrete in terms of prioritizing building strength and promoting sustainability.

References and Resources

- American Society of Mechanical Engineers, Feb. 18, 2020. "Low-Carbon Concrete Can Fight Global Warming"
- Bellona, Apr. 13, 2018. "Building with Low Carbon Cement is Affordable"
- Blue Planet Concrete
- Building Green, Jan. 7, 2020. "Marin County First to Adopt Low-Carbon Concrete Code"
- Carbicrete
- Carbon Cure
- C40 Cities
- Linkedin, Jul. 20, 2022 "Carbon Concrete: Sustainable Building Material of the Future"
- Linkedin, Dec. 4, 2019 "I'm On A Mission to Build Silicon Valley with Sustainable Concrete - Starting with LinkedIn's New HQ!"
- Commercial Cafe Linkedin Middlefield Campus Date

- Carbon Cure, Jan. 19, 2021. "Central Concrete Meets Bay Area Demand for Low-Carbon Concrete"
- Carbon Cure. "Reducing Carbon, One Truck at a Time"
- Health Product Declaration Collaborative. "SFO: Poised to Become the World's Most Sustainable, Healthy Airport"
- Project Drawdown: Alternative Cement
- Stop Waste: Low-Carbon Concrete Code Amendment Toolkit. stopwaste.org/concrete
- Worldometer: CO2 Emissions by Country
- Zero Energy Project, Nov. 9, 2020. "Low-Carbon Concrete Starting from the Ground Up"

Document last updated January 2024