The following is a part of the Concrete Innovations series. This series features products and technologies that have innovated the concrete industry. Today's article is the second in the series, and it is focused on sustainability. Part one's focus was on durability and disaster-proofing, while part three of the series is focused on design.

Durability and sustainability often go hand in hand. After all, the longer something lasts, the less often you need to produce it. Concrete is a prime example of something that is extremely durable and sustainable; however, there is significant room for improvement in its sustainability. Although concrete lasts a long time and needs to be replaced significantly less often than alternative building materials, the production of concrete is not very environmentally friendly. This is due to the fact that the cement making process produces so much carbon dioxide. Although the use of admixtures can often reduce the amount of cement needed in a given concrete mix, concrete and cement production are still so prevalent that cement production is responsible for approximately 5% of the man-made carbon dioxide emissions on the planet. This article will cover four different technologies that aim to improve the sustainability of concrete in various ways.

Sustainability Innovation 1: Carbon Dioxide Sequestering Concrete

Canadian company CarbonCure has found a way to reduce the carbon dioxide emissions typically associated with concrete production. Their method involves sequestering carbon dioxide within the concrete. CarbonCure installs their equipment on pre-existing machinery in the concrete production facility, with the whole installation process taking less than a day. Carbon dioxide is then introduced into the mix, which results in many benefits. First of all, this system uses carbon dioxide that would otherwise be wasted in the process, which cuts down on the overall emissions involved in concrete production. The final product complies with all industry standards for compression, absorption, unit weight, shrinkage, and dimensional tolerances.

Besides meeting all CSA (Canadian Standards Association) and ASTM (American Society for Testing and Materials) specifications, CarbonCure's process does not change the size or colour of the final product. What CarbonCure does change is the strength of the concrete. When the carbon dioxide has been sequestered inside the concrete, a chemical process transforms it into solid limestone. This results in stronger concrete that is also greener.

Sustainability Innovation 2: Hemp Concrete

An example of a wall made with hemp concrete

Changing the concrete process to make it more green is an important step in reducing global carbon dioxide emissions. However, one company in Idaho decided to take a different approach to changing the concrete industry. Hempitecture developed a way to use hemp and a mineral bonding agent to make all-natural concrete that is made from renewable resources that are carbon negative. Hempitecture's product is carbon negative because hemp takes carbon dioxide out of the air as it grows; unlike traditional cement, it does not require burning; and due to its high insulation factor, it greatly reduces heating costs and energy

consumption.

Hempitecture has found a way to take a plant that has an extremely fast regrowth rate and to transform it into a product that can not only be used to build greener, but to build better. Their product sucks carbon dioxide out of the air and acts as extremely effective insulation, which reduces the carbon footprint of the whole process significantly. While hemp concrete has been used in residential buildings before, Hempitecture will soon be using their product to build the first non-residential hemp building in the United States.

Sustainability Innovation 3: Smog-Eating Cement

A street in the Netherlands paved with smog-eating concrete

A chemical compound commonly found in sunscreen could reduce smog levels in cities. Titanium dioxide is used in a variety of products, including toothpaste, food dye, paint, and

now concrete. Titanium dioxide reacts with sunlight to convert nitrogen oxide and sulphur oxide (gases which usually create smog) into nitrates or sulphates (which are harmless) that get washed away by rainwater.

Researchers at a Dutch university conducted an experiment where they monitored the temperature and gas levels on a street coated with titanium dioxide. They compared their results to a different portion of the same street which had not been coated. Their findings indicated a 19% average decrease in greenhouse gases, with up to a 45% decrease on days with ideal conditions (low humidity and high radiation). A stretch of a busy road in Chicago has also been treated with the spray, with results being monitored. Positive results could help this product to gain traction in North America and throughout the world. Currently, the cost is the biggest obstacle to mainstream adoption.

Italcementi's Research and Development Center

Meanwhile, Italian cement company Italcementi has created a mix with titanium dioxide added directly to it. Originally, titanium dioxide was added in an attempt to make very white cement. The company later noticed that there seemed to be reductions in pollution as a result. Italcementi also paved a road with this mix, prompting residents to report better-smelling air. An additional benefit to this cement is its self-cleaning nature. When the nitrates and sulphates are washed away by rainwater, a clean building is left behind, without the need for chemical cleaning. For example, Air France’s headquarters in Paris has remained extremely white throughout the years, thanks to this cement.

Air France's headquarters

Whether titanium dioxide is used in cement or as a coating for concrete, its anti-polluting properties are clear. When combined with the self-cleaning advantages, it's clear that these products have the potential to clean the air in our cities and to leave behind pristinely white buildings while they do it.

Sustainability Innovation 4: Rain Filtering Concrete

With today's emphasis on sustainability, houses that capture rainwater for watering plants and flushing toilets are not uncommon. However, drinking water still tends to come from the tap. Hungarian company IVANKA has developed a system using "bioconcrete" to purify the rainwater. Without using chemicals, the system captures rainwater and eventually stores it in a concrete cistern. On the way down, the water flows through a series of filters, including one made of bioconcrete. Stainless steel pipes further remove impurities en route to the cistern.

IVANKA's Rain House

So far, all of the company's tests from their testing facility in a Hungarian national park have demonstrated positive results. The main concerns surrounding this innovation seem related to the effectiveness of the filtering system where the water is extremely polluted. The rainwater near a national park and the rainwater in a polluted inner city will not contain the same level of contaminants. Another concern is that many areas do not receive enough rain to make this a viable option; however, IVANKA estimates that this system could be used in approximately half of the world's countries.

The water that falls on the glass roof is filtered through "bioconcrete"

The company intends to license their technology everywhere, and even to make portions of their technology available open source. Areas that do not have access to fresh water would have more options for getting it, should this technology catch on. Additionally, the more people who use this system, the less people will be putting a strain on the limited amount of fresh water that is accessible today. Maybe the world's fresh water shortage can be solved by something as common as concrete.

Sources:

Introduction

Natesan Mahasenan, Steve Smith, and Kenneth Humphreys via Science Direct

Carbon Dioxide Sequestering Concrete

CarbonCure

Hemp Concrete

Hempitecture

Image: Culburra Hemp House

Smog-Eating Cement

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MM Ballari and HJ Brouwers via PubMed

Rain Filtering Concrete

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