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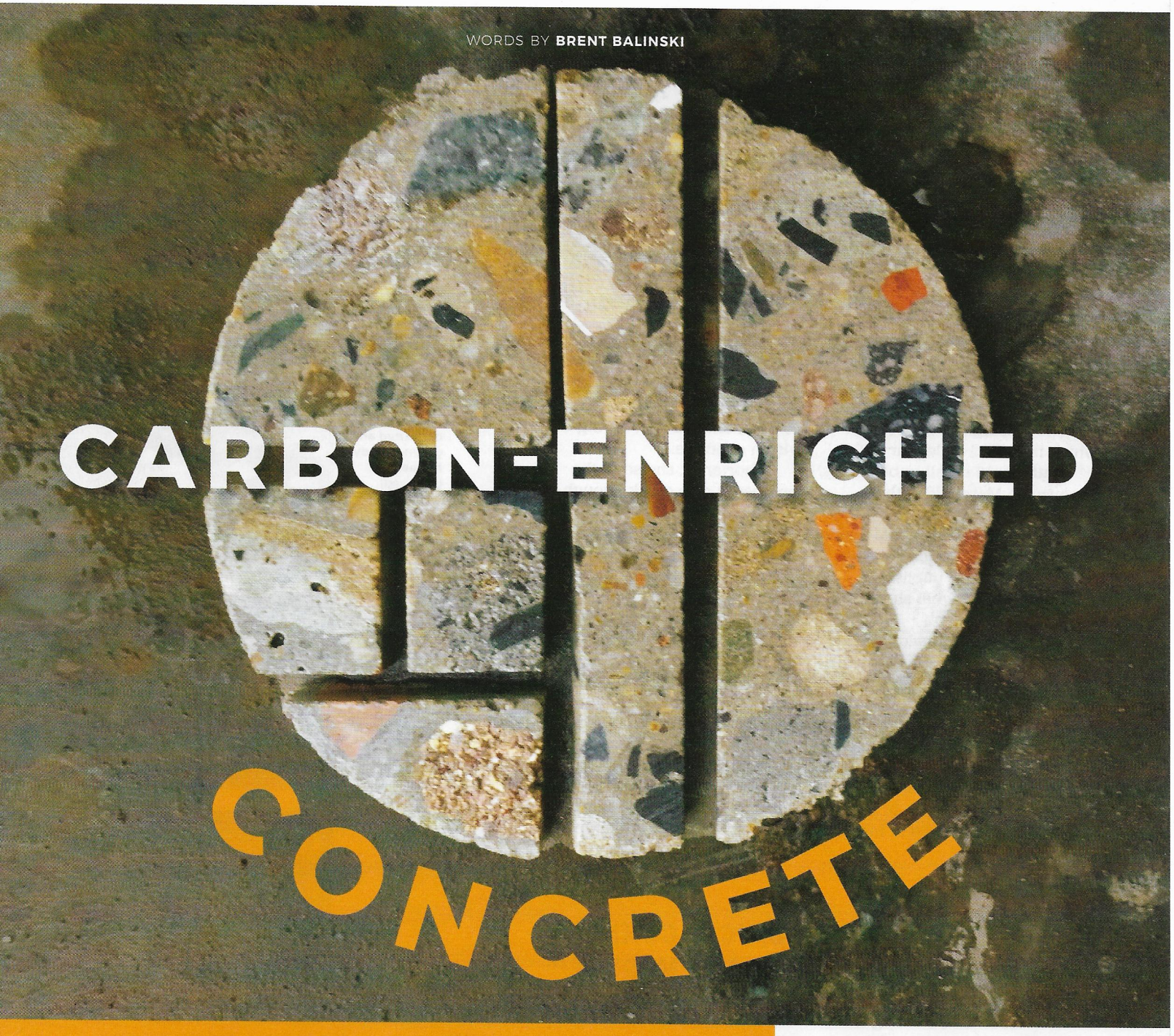
create

ENGINEERING IDEAS INTO REALITY

ENGINEERS AUSTRALIA

3D PRINTED BONES

HALA ZREIQAT IS BUILDING NEW BONES FOR ACCIDENT AND CANCER VICTIMS



WORDS BY **BRENT BALINSKI**

CARBON-ENRICHED CONCRETE

A NEW COMPANY IS COMMERCIALISING ITS IDEAS FOR HOW TO USE RECYCLED CONCRETE AND CARBON DIOXIDE IN CONSTRUCTION.

VIVIAN TAM earned her PhD from City University of Hong Kong in 2005 when she invented a two-stage mixing approach for recycled concrete.

She then moved to Australia to join Griffith University, and has been at Western Sydney University (WSU) since 2009.

There, she is Associate Dean (International) and Professor in Construction Management, specialising in topics including sustainable construction, green building and life-cycle assessment.

ABOVE: A sample of Ecobond's recycled concrete. BELOW: Professor Vivian Tam

The past few years have seen her return to recycled concrete for work that has earned her a runner-up place at the prestigious Scopus Researcher of the Year Awards for Excellence in Creating a Sustainable Future. ▶

This work has also been spun out into a company, Ecobond, which launched in January 2018.

"I put a hold on all publications because, in March 2017, this particular project also got selected by Innoyvz's Waste and Recycling Technologies Program," Tam tells *create* of publishing developments on what she calls CO_2 Concrete.

"And that's why I held up all the publications – because we want to commercialise the product."

Work on the method to create recycled concrete started sometime around 2015. A recent paper explains the process: it puts recycled aggregate in a pressurised chamber and injects carbon dioxide.

recycled concrete, and, according to Tam, offers a cost saving over virgin concrete.

Importantly, she says, the process is also quick enough to industrialise.

"I cannot tell you some of the confidential details regarding the carbonation process, but I can say that my process is much, much faster and much more economical compared to what is available in the market," says Tam.

"I can give you examples from publications in other countries where a batch could be carbonated for 24 days."

Throughput increases with chamber size. The most recent iteration is 1.2 m in diameter by 1.6 m, and the first prototype was 50 cm by 50 cm by 35 cm.

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The carbon conditioning turns calcium hydroxide into calcium carbonate with small crystals. These increase the density and strength of the material and decrease water absorption – each of which has limited the use of recycled aggregates for structural concrete.

Many other researchers are developing processes to cure concrete with carbon dioxide, but this method uses

There was a lot of experimental work to begin with, says Tam, with trial and error on mixing practices. Following that, machine-learning experts made sense of the results.

Models have been developed where industrial strength requirements and other constraints can be used as inputs, and a mix of a certain proportion of recycled and virgin aggregate can be recommended.

Conversely, the proportion of recycled versus virgin aggregate can be input, and the resulting strength and other properties are the outputs.

TESTING THE MECHANICAL AND PHYSICAL PROPERTIES OF CARBON-ENRICHED CONCRETE

01. Fresh concrete is mixed

02. Slump testing

03. Fresh concrete is compacted into moulds (pictured)

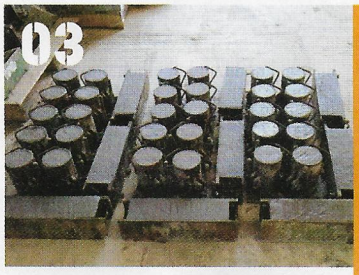
04. Concrete samples measured and ground, ready for testing (pictured)

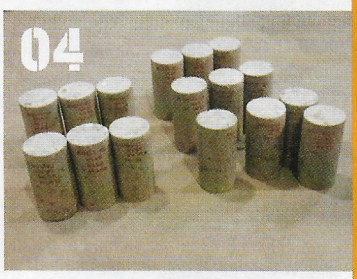
05. Compressive strength

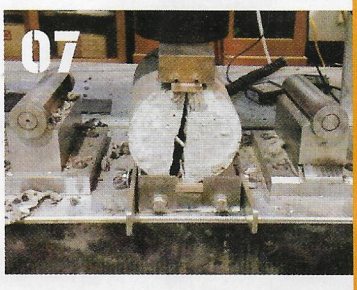
06. Modulus of elasticity

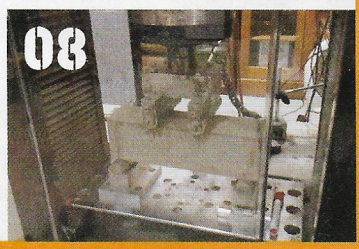
07. Tensile strength (pictured)

08. Flexural Strength (pictured)









ABOVE: Material used in the concrete is weighed to determine particle density and water absorption.

REDUCING THE IMPACT OF CONCRETE

Cement is an irreplaceable man-made substance, though one with a large carbon footprint.

Its production contributes an estimated five per cent of all greenhouse gases, both from creating the heat required in

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a kiln and through the carbon dioxide that escapes when limestone is broken down by heat with other materials.

Possibilities for mitigating emissions include substituting cement for geopolymer, introducing methods of carbon capture and storage or usage, and injecting carbon dioxide back into cement.

According to Tam's figures, at the current levels of concrete production in Australia, CO_2 Concrete could provide a net lifecycle benefit of $16 billion – versus a loss of $22 billion for using virgin concrete – and save 2.68 billion kg of carbon dioxide emissions.

The work of Ecobond – which Tam founded with fellow CO_2 Concrete inventor and WSU academic, Associate Professor Khoa N. Le – is awaiting a patent. This is one of several important steps ahead in 2020, she believes.

"It will be important for me to really pursue getting these products into the commercial scale," Tam adds.

"Having someone using it [and] partnering with concrete suppliers or contractors or other agencies with the network to use concrete as well, because I really want this concrete to be used in Australia. And hopefully it can go further." ●

ABOVE: Using CO_2 concrete for a cattle drinking station. BELOW: The concrete's first application was for a biosecurity platform.

Weight test

The first application of Western Sydney University (WSU) Professor in Construction Management Vivian Tam's CO_2 Concrete was a small 40 cm by 50 cm biosecurity platform created for WSU's Hawkesbury campus, which was used to clean people's boots when they entered and exited.

In March 2019, her company Ecobond teamed up with Volumetric Concrete Australia to make four 3 m by 3 m slabs that are able to support the weight of cows drinking from a trough. This provided important validation.

"Each is about a tonne in weight and that means about five to six tonnes on the slabs, which is like a weight test for us at this stage," recalls Tam.