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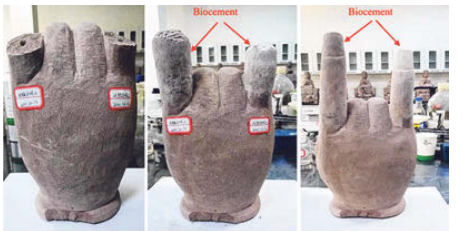
Dr Wu Shifan (left), senior research fellow at NTU's Centre for Urban Solutions, and Professor Chu Jian, chair of the School of Civil and Environmental Engineering and director of the Centre for Urban Solutions, who led the NTU research team, holding blocks of biocement made from urea and carbide sludge. PHOTOS: NTU

Dr Yang Yang restoring (below) a Buddha hand from the Dazu Rock Carvings, a Unesco World Heritage Site in China, with the biocement in Chongqing University in China. The team member and former NTU PhD student and research associate at the Centre for Urban Solutions is currently a postdoctoral fellow at Chongqing University. The biocement solution is colourless, allowing restoration works to maintain the carving's original colour.



NTU scientists transform industrial waste, urine into renewable cement

Biocement can be used in projects to reduce beach erosion and to repair monuments

Ang Qing and Soh Pei Xuan

Scientists from Nanyang Technological University (NTU) have found a way to transform urine and industrial waste into a renewable type of cement.

Biocement has the potential to be used in construction projects to reduce beach erosion or for building freshwater reservoirs in a desert, for example, NTU said in a statement yesterday.

It can also be used to seal cracks and repair monuments like rock carvings and statues.

Producing biocement entirely made from waste materials paves the way for more sustainable and cost-efficient construction projects, as urine and waste are free and the high temperatures needed for traditional cement-making methods are not required in the production of biocement, the NTU team said.

Professor Chu Jian, chair of the School of Civil and Environmental Engineering, who led the NTU research team, said: "Our research makes biocement even more sustainable by using two types of waste as its raw materials. In the long run, it will not only make it cheaper to manufacture biocement, but also reduce the cost involved for waste disposal."

The project marks the culmination of four years of research and development that began in 2017, when the researchers noticed the high cost of transporting carbide sludge – a waste material from producing acetylene gas that is commonly used for welding – from Singapore to Malaysia.

"Instead of transporting carbide waste and paying costly transport fees, we can put the carbide waste to good use while reducing waste," said Dr Yang Yang, a team member and former NTU PhD student and research associate at the Centre for Urban Solutions, who is currently a post-doctoral fellow at Chongqing University.

The NTU team's biocement production process harnesses a reaction that occurs when industrial carbide sludge is combined with acid, urine and bacteria.

When the precipitate is added to soil, it bonds soil particles together and fills the gaps between them, creating a compact mass of soil. This forms a strong, sturdy and less permeable block of biocement.

According to Prof Chu, traditional cement-making processes burn raw materials at temperatures of more than 1,000 deg C, which can produce a lot of carbon dioxide. In contrast, the production of biocement can be done at room temperature.

The process does away with the need for mining limestone – a finite resource that is a key ingredient in cement production.

"By extracting calcium from carbide sludge, we make the production more sustainable as we do not need to use materials like limestone which has to be mined from a mountain," said Dr Yang.

The colourless quality of the precipitate also allows the original colour of soil, sand or rock to be preserved when biocementation – the process of turning soil into cement with the precipitate – occurs.

This means that old rock monuments and artefacts can be restored without altering their colour.

For example, Dr Yang has used biocement to repair old Buddha monuments in China, such as broken-off fingers of a Buddha's hand, by sealing gaps in the cracks.

In collaboration with several national agencies such as the National Parks Board, the NTU team is currently trialling the biocement at East Coast Park to prevent beach erosion.

The biocement is also being considered for use as cultivation ground for coral reefs as coral larvae like to grow on calcium carbonate, which is a major component of the biocement.

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