NTU Develops Sustainable Construction Tech

Alita Sharon(https://opengovasia.com/author/alita-sharon/) | April 26, 2022(https://opengovasia.com/2022/04/26/)

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Researchers from Nanyang Technological University, Singapore (NTU Singapore) have developed technology that uses recycled glass in 3D printing, opening doors to a more environmentally sustainable way of building and construction.

Glass is one material that can be 100% recycled with no reduction in quality, yet it is one of the least recycled waste types. Concurrently, grow urbanisation and infrastructure development have led to a shortage of sand, with climate scientists calling it one of the greatest sustainability c century.

For these reasons, the NTU research team is seeking to find ways to recycle glass by 3D printing it into items for everyday use. One of their in recently in the Journal of Building Engineering used a specially formulated concrete mix comprising recycled glass, commercial cement produ to 3D print a concrete bench.

By figuring out the optimal concrete formulation, the NTU research team was able to successfully 3D-print a 40cm tall L-shaped bench as a p material could be 3D printed into an everyday structural (weight-bearing) product. In lab compression tests and filament quality (strength) test showed excellent buildability – the printed concrete does not deform or collapse before the concrete cures – and extrudability, meaning the spe enough to flow through the hoses and print nozzle.

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The principal investigator of the study Professor Tan Ming Jen of the NTU School of Mechanical and Aerospace Engineering (MAE) said tha feasible formula, demonstrating for the first time that glass can indeed be used to 3D-print a bench with excellent structural integrity.

As a result of the successful proof-of-concept, the NTU research team believes their development offers a new pathway to recycling glass was greener building and construction industry for Singapore and beyond. The new development builds on previous 3D printing for construction r his team at NTU's Singapore Centre for 3D Printing (SC3DP).

The NTU scientist was also behind the 3D printed bathroom project in 2019, where an unfurnished bathroom was printed in 12 hours in Singa required for conventional construction of the same facility. The latest innovation is an example of ground-breaking research that supports the N which seeks to address humanity's grand challenges on sustainability and accelerate the translation of research discoveries into innovations th on the environment.

Replacing sand in concrete

Sand is a vital part of concrete, ensuring its durability. The United Nations Environment Programme reports have also revealed that, around th extraction from rivers has led to pollution, flooding, and other environmental consequences.

The first author of the NTU-led study, Andrew Ting, a researcher at the SC3DP stated that the research has shown that recycled glass can be u per cent of the sand in concrete for 3D printing. The result is a concrete bench with a mechanical strength that meets acceptable industrial stan their solution has great potential to relieve the demand for sand in this sector in the future.

Moreover, as glass is a material that is naturally hydrophobic and so less water is required to create a concrete mix suitable for 3D printing use

How the L-shaped bench is 3D printed

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Through detailed and extensive analysis and testing, the NTU research team established the optimal parameters for the recycled-glass concrete allow it to be 3D-printed. Components of the mixture include recycled glass crushed to different size classes (Medium, Fine and Superfine), co products, water, and other additives.

To enable printing, the team adjusted the control systems of the 3D printer to match the flow rate of the nozzle to the hardening properties of t was then carried out in a single build using a 4-axis gantry robotic printer which has a print volume of 1.2 metres x 1.2 metres x 1 metre.

The specially designed concrete mixture was fed to a pump and transported to a nozzle mounted on the robotic arm, depositing the material la the digital blueprint. The technology and know-how employed in this research project are protected by a Technology Disclosure filed through enterprise company which is also owned by the university.

Moving forward, the NTU research team, in collaboration with a Singaporean start-up, will look at 3D printing larger scale and more diverse s recycled glass concrete mix, and to optimise the printing algorithm for consistent performance.