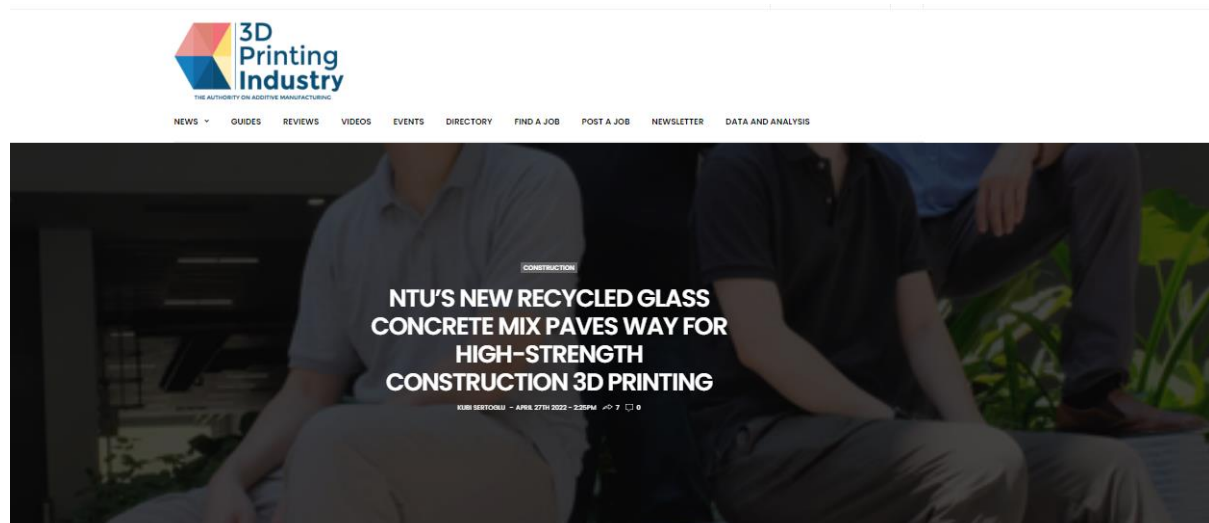


<https://3dprintingindustry.com/news/ntus-new-recycled-glass-concrete-mix-paves-way-for-high-strength-construction-3d-printing-208511/>



Researchers from Nanyang Technological University (NTU Singapore) are exploring the use of recycled glass as a replacement for sand in concrete 3D printing, paving the way for environmentally-friendly building materials.

Many of today's conventional concrete formulations contain natural sand as a primary component. Unfortunately, due to urbanization and infrastructure development, sand is slowly becoming a scarce resource so there's a growing need to find a suitable alternative.

Glass, on the other hand, is one of the least recycled types of waste, despite it being completely recyclable without a reduction in quality. According to the National Environment Agency of Singapore, 74,000 tons of glass waste were produced in Singapore in 2021, but only 13% of it was recycled. The remainder was either incinerated or dumped in a landfill.

In a bid to make use of glass' untapped potential, the NTU team created a recycled glass-based concrete mix and used it to 3D print a 40cm-tall concrete bench. The proof-of-concept successfully demonstrates that their special material formulation can be used to additively manufacture everyday load-bearing objects, boding well for high-strength construction.



The 3D printed bench. Photo via NTU Singapore.

Why does concrete need aggregates?

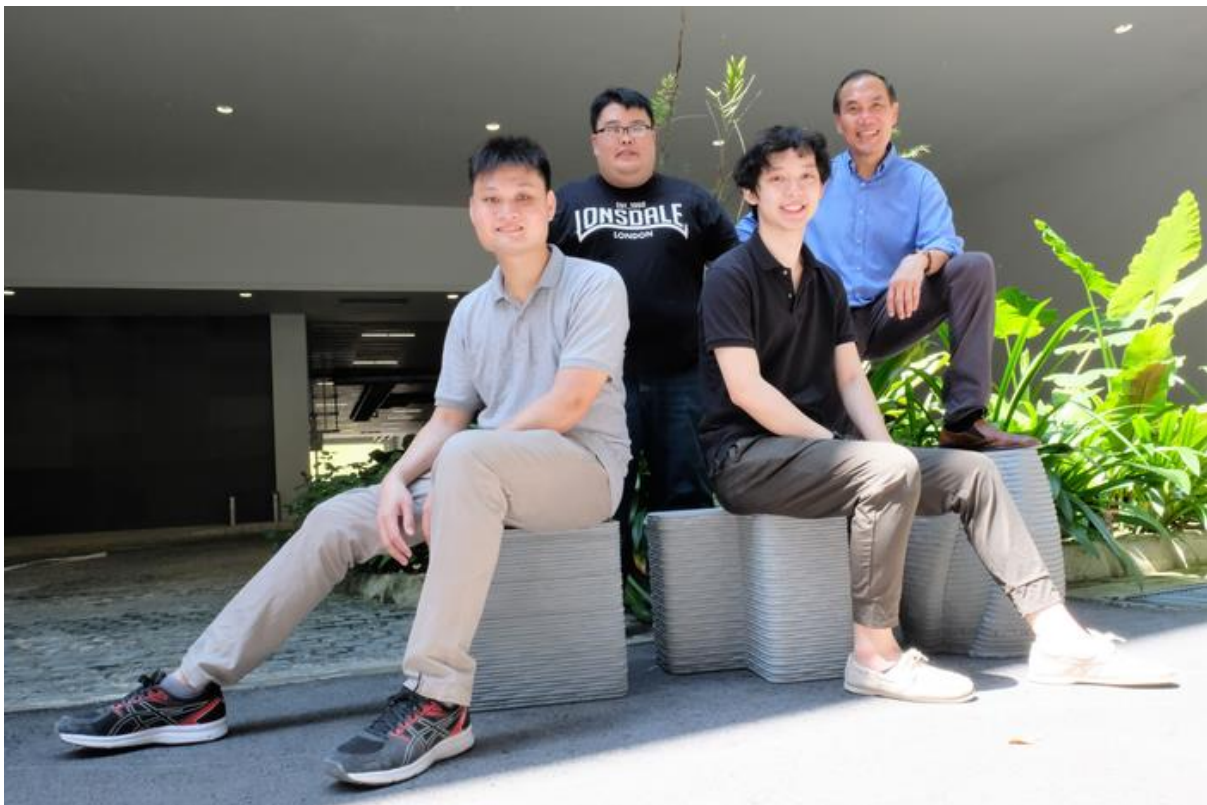
Concrete is a mixture of portland cement, water, and aggregates such as sand, gravel, and glass. The aggregate materials act as a binder for the mixture and without them, water-based concrete doesn't hold and isn't strong enough to bear significant compressive loads. Aggregates also serve to reduce the porosity of concrete mixtures, acting as a filler to further increase strength.

One of the most commonly used aggregates in the construction sector is natural river sand, which is extracted from river beds and riverbanks. Although it may be readily available on the market, the overuse of river sand can lead to pollution, flooding, and other extremely damaging consequences for local ecosystems that live in and around rivers.

Glass, although promising, has historically been unable to match the strength properties of conventional sand, so it's often considered an inferior alternative in construction 3D printing. According to the NTU

researchers, however, no one has been able to 3D print a recycled glass-based concrete structure as strong as the bench until now.

Professor Tan Ming Jen, principal investigator of the study, said, “The main challenge in formulating 3D-printable concrete mixtures is to figure out just how much of each component to add to obtain a structurally sound structure with minimal defects. Our team has come up with a feasible formula, demonstrating for the first time that glass can indeed be used to 3D-print a bench with excellent structural integrity.”



Members of the NTU research team include (L-R, standing) Lim Jian Hui, Prof Tan Ming Jen, (L-R, sitting) Andrew Ting, and Noel Tan. Photo via NTU Singapore.

Recycled glass as a sand replacement

To kick the project off, the NTU researchers first established the optimal composition of their 3D printable recycled glass concrete mixture through extensive analysis and testing. The mix included commercial cement, water, additives, and recycled glass crushed to a variety of sizes from ‘medium’ to ‘super fine’.

A four-axis gantry-based 3D printer with a build volume of 1.2 x 1.2 x 1m was then used to 3D print the L-shape concrete bench. According to the researchers, the material was highly extrudable, meaning it was fluid enough to flow through the print nozzle without any issues. It also reportedly showcased excellent buildability as it didn't collapse or even deform during subsequent compressive strength testing.

Andrew Ting, first author of the study, said, "Our research has shown that recycled glass can be used to replace up to 100% of the sand in concrete for 3D printing. The result is a concrete bench with a mechanical strength that meets acceptable industrial standards."

The NTU research team now intends to fine-tune the printing algorithm for consistent performance and partner with upcycled glass startup [Soda Lemon](#) to 3D print even larger structures using their sustainable concrete mix.

Further details of the study can be found in the paper titled '[Extrudable region parametrical study of 3D printable concrete using recycled glass concrete](#)'.

Glass aggregates have been explored in construction 3D printing research in the past, albeit with less success. Researchers at [Technische Universität Berlin](#) (TU Berlin) and [Brunel University](#) recently replaced the sand in 3D printable concrete with [recycled glass, limestone, and plastic fillers](#). The team managed to drastically improve the strength and thermal conductivity of the material.

Elsewhere, researchers from [RMIT University](#) have previously developed an [eco-friendly 3D printable concrete material](#) that uses recycled glass as an aggregate. With its work, the RMIT team believes it can propagate circular economy principles in the construction sector, bridging the benefits of 3D printing and sustainable concrete production.

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Featured image shows members of the NTU research team. Photo via [NTU Singapore](#).