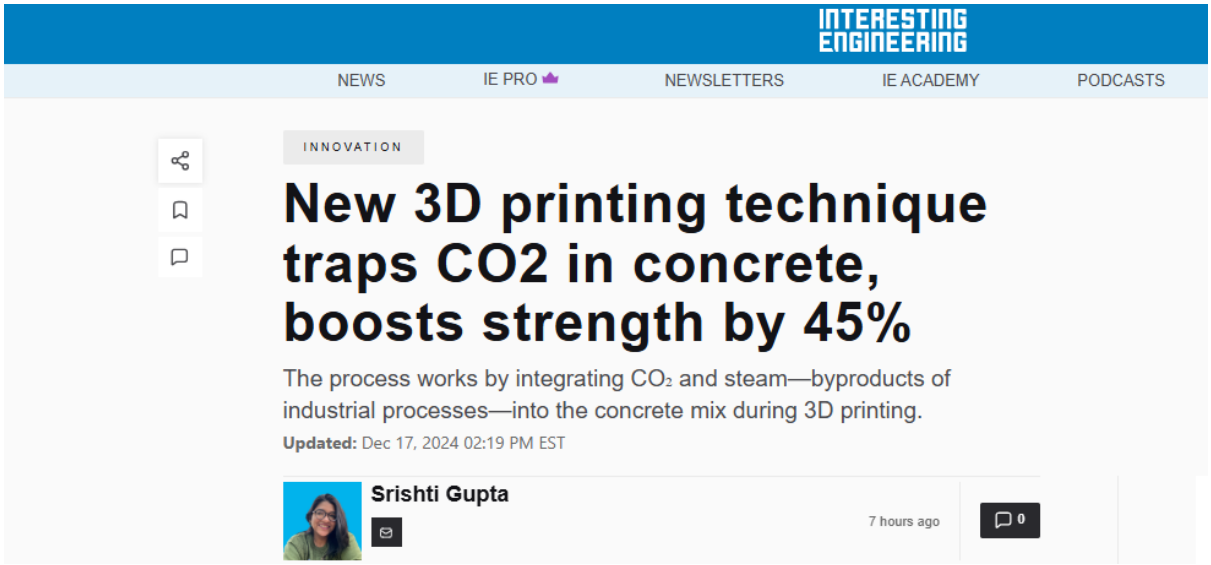
https://interestingengineering.com/innovation/3d-printing-traps-co2-in-concrete



Sample of a concrete wall constructed using the newly developed 3D concrete printing method.

NTU Singapore

Scientists at Nanyang Technological University, Singapore (NTU Singapore) have pioneered a 3D concrete printing method that captures and stores carbon dioxide, marking a major step toward reducing the construction industry's environmental footprint.

The innovative technique offers a promising solution to mitigate cement's massive carbon emissions.

The process works by integrating CO_2 and steam—byproducts of industrial processes—into the concrete mix during 3D printing. As the material is printed, CO_2 reacts with components in the concrete, forming a solid, stable compound that remains locked within the structure.

Steam, in turn, enhances CO_2 absorption, boosting the material's strength and printability. Lab tests confirmed that the new technique not only traps more carbon but also produces concrete that is stronger and more durable than conventional 3D-printed concrete.

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Stronger, greener, more efficient

Cement production is responsible for approximately 1.6 billion metric tonnes of CO_2 annually—about eight percent of global emissions. By reducing material use, construction time, and labor needs, the NTU-developed method provides a greener alternative for building practices.

In detailed lab evaluations, NTU researchers found that the carbon-infused 3D-printed concrete demonstrated a 50 percent improvement in printability, enabling faster and more precise construction. Its mechanical properties also showed remarkable gains: the printed structure was up to 36.8 percent stronger under compression (resistance to weight) and 45.3 percent stronger in bending (flexibility) compared to standard 3D printed concrete.

Most notably, the method captured and stored 38 percent more CO_2 than traditional 3D printing processes, making it a significantly greener option for construction projects.

Professor Tan Ming Jen, principal investigator of the study from NTU's School of Mechanical and Aerospace Engineering (MAE) and the Singapore Centre for 3D Printing (SC3DP), emphasized the broader implications of the technology. "The building and construction sector causes a significant portion of global greenhouse gas emissions."

"Our newly developed 3D concrete printing system offers a carbon reducing alternative by not only improving the mechanical properties of concrete but also contributing to reducing the sector's environmental impact. It demonstrates the possibility of using CO_2 produced by power plants or other industries for 3D concrete printing."

Shaping the future of sustainable construction

The development of this carbon-sequestering technology arrives at a critical time as industries worldwide race to meet climate change targets. PhD candidate Lim Sean Gip, the study's first author, underscored the urgency of the team's work: "We are at a critical time where the world is accelerating efforts to meet climate change targets. We believe our technology could contribute to making the construction industry more sustainable."

Dr. Daniel Tay, co-author and Research Fellow at NTU's School of MAE, highlighted the innovation's dual benefits: "Our proposed system shows how capturing carbon dioxide and using it in 3D concrete printing could lead to stronger, more eco-friendly buildings, advancing construction technology."

Looking ahead, the researchers have filed a joint US patent application with their collaborators to secure the innovation's intellectual property. Future research will focus on optimizing the printing process for greater efficiency and exploring the use of waste gases—rather than pure CO_2—further increasing the system's environmental benefits.

RECOMMENDED ARTICLES

The research has been published in *Carbon Capture Science & Technology*.