CARBCOMN

Carbon-negative compression dominant structures for decarbonized and deconstructable concrete buildings

LOOKING BACK TO THE FIRST YEAR OF CARBCOMN

MAJOR EXPERIENCE AND ACHIEVEMENT BY...

UNIVERSITEIT GENT

"Our key highlight in the past year was formulating an initial 3D-printable mix from solely non-activated slags, while balancing the often conflicting requirements of 3DCP. The success of the first 3D-print in collaboration with the involved partners offered an enriching experience in developing circular concrete from secondary product systems."

Tesis s.r.l. Tecnologie Emergenti a Servizio dell'Ingegneria Strutturale

"At TESIS, we have been working on technical aspects as well as coordination. In cooperation with Orbix and EMPA, we began exploring the potential of recycled concrete aggregates as a carbon sink. We also set up communication and dissemination activities and interacted with other projects in the DigiTrio portfolio."

orbix

"The collaboration between Orbix and UGent has resulted in an initial 3D-printable mix based on slag-derived sand and binder. Orbix further improved the mix design and carbonation process, reducing the carbonation time by roughly 85% while maintaining the required strength."

TECHNISCHE UNIVERSITÄT DARMSTADT

"Our key highlight this year was combining microstructural analysis and pore-scale modeling to understand how carbonation transforms binder pore networks. This integration offers valuable insight into optimizing carbonatable systems for CO_2 curing and durability performance."

Empa

"Our key highlight in the past year comprised both the material and structural scales: at the material level, using CT scanning to study how carbonation affects the porosity of non-activated slag-based printable concrete; and at the structural level, deepening our understanding of the mechanics of compression-dominated arch structures."

incremental3d

"Now, one year into research, we are part of generous exchange of knowledge and experience. Witnessing progress on the 3d printing and thought-through research connected to the material chemistry as well as structural systems to be realized, we are very happy to participate and contribute to CARBCOMN as an industry partner."

DIGITRIO

DigiTrio (Digitalization for a Novel Triad of Design, Fabrication, and Materials) unites ten ambitious projects funded under the EIC Pathfinder Challenge, each exploring the transformative potential of digitalisation within the Architecture, Engineering, and Construction (AEC) sector. Together, we form a strategic research ecosystem to reshape how buildings and structures are conceived, built, and perform. DigiTrio promotes collaboration across disciplines and borders, offering unique opportunities to build future value chains, strengthen industrial partnerships, and accelerate commercialisation potential through joint portfolio activities. DigiTrio is a dynamic platform for innovation at the intersection of science, technology, and architecture, advancing sustainable and intelligent solutions for the built environment.

CARBCOMN

ALGOLOAM

AM2PM

ARCHIBIOFOAM

FLEXIFORM

PANTAREI

SCENE-B

STACK

UTS

RAW

As a portfolio, DigiTrio is committed to advancing sustainable construction through shared goals such as reducing embodied CO_2 and enabling predictive design and manufacturing. We aim to demonstrate measurable carbon reductions, support smart construction planning, and establish scalable, environmentally responsible practices across the AEC sector.

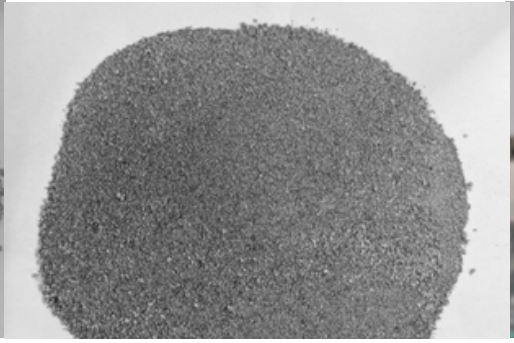
SUCCESFULL FIRST BLOCK PRINT TRIAL

A MAJOR MILESTONE TOWARD CARBON-NEGATIVE, COMPRESSION-DOMINANT CONCRETE STRUCTURES

STEP 1 - DEVELOPMENT OF PRINTABLE MATERIALS

Toward carbon negativity, we focus on the development of printable mix composed entirely of carbonatable secondary binders and aggregates. Key performances, such as flow table value retention and yield stress evolution, were evaluated. To facilitate rapid prototyping and evaluation of printability, a simple 2D printing setup was employed, allowing for accelerated iteration on mix rheology, extrusion stability, and early shape retention, providing critical feedback before scaling to robotic 3D printing.

SECONDARY BINDER

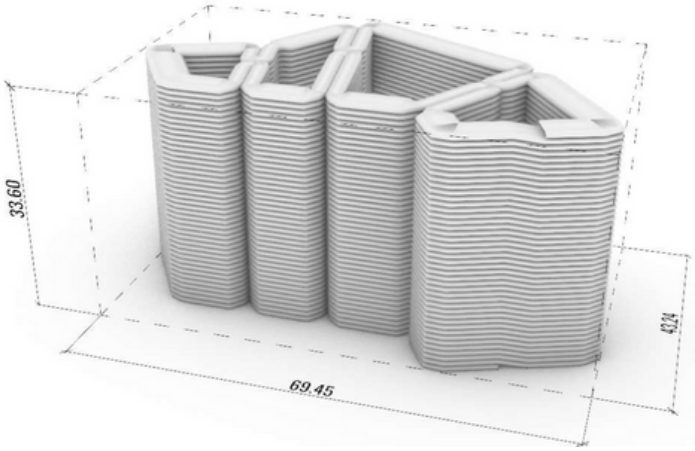


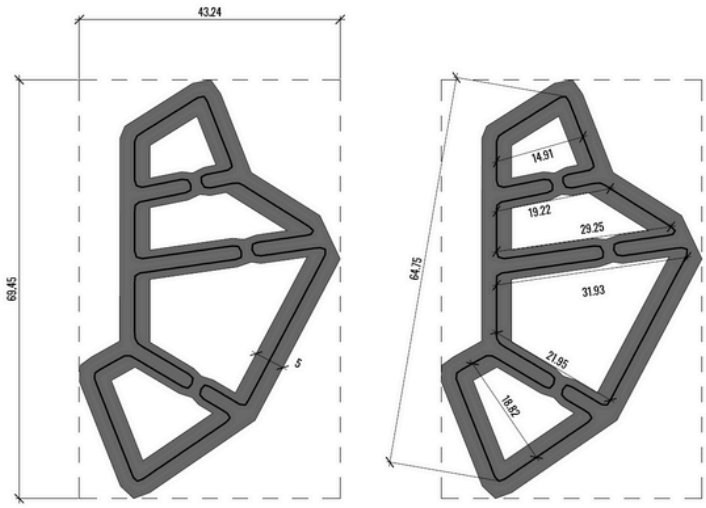
SECONDARY AGGREGATE

2D PRINTING SETUP

STEP 2 - BLOCK GEOMETRY AND PRINT PATH

The block geometry reflects key principles of compression-based design. The initial geometry and corresponding print path were proposed by In3D based on the project's design intent. The print path code was subsequently refined and adapted in close collaboration between the teams at In3d and UGent to ensure compatibility with the 6-axis robotic arm and setup used for the print-trial.





STEP 3 - BLOCK PRINTING AND CARBON MINERALIZATION

The block printing was executed using the 6-axis robotic arm system (ABB IRB 6650) at UGent. Two prototype blocks were successfully printed with no significant deformation or collapse, each consisting of 42 layers with a layer height of 8 mm. Then, the printed blocks were carefully transferred to controlled carbonation chambers for curing. Different CO_2 concentrations were adopted to investigate the impact of CO_2 availability on mineralization efficiency, which were further verified by carbonation degree and mechanical properties.

6-AXIS ROBOTIC ARM SYSTEM

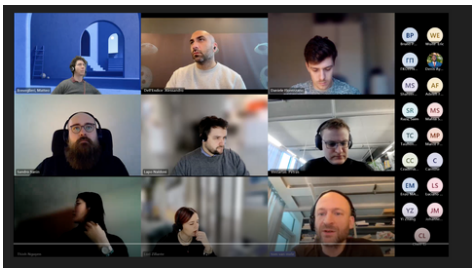
MINERALIZATION OF BLOCK IN CARBONATION CHAMBER

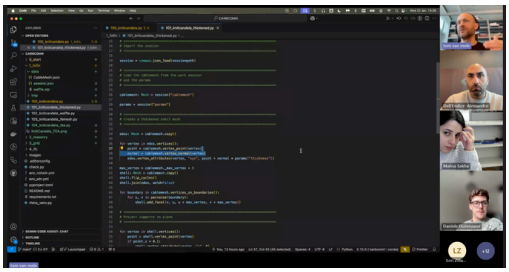
COMPAS WORKSHOP @ ETH ZURICH

On 22 January 2025, the CARBCOMN consortium convened for a COMPAS workshop, marking a foundational milestone in our shared journey toward sustainable, circular, and digitally integrated 3D-printed concrete construction.
The workshop introduced COMPAS—the open-source, Python-based computational framework developed at ETH Zurich that integrates geometry, structural analysis, robotic fabrication, and environmental performance assessment—to all consortium partners.

The program consisted of three main parts:

- Introduction to COMPAS – We explored its architecture, core library, and powerful extensions, with a focus on those most relevant to CARBCOMN.
- Hands-on demos – Participants engaged with COMPAS tools in live sessions, gaining practical insights into how the framework unites geometry design, material specification, structural simulation, and fabrication in a single workflow.
- Integration discussions – We examined how COMPAS can serve as the computational backbone of CARBCOMN, enabling transparent collaboration, minimizing data loss, and embedding sustainability and life-cycle analysis (LCA) into every design iteration.





This workshop has laid the foundation for deep integration of COMPAS across all CARBCOMN activities, ensuring that computational workflows become a central driver of innovation and sustainability within the project pipeline. We look forward to building on this momentum together.

STAY TUNED

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This issue of the newsletter is brought to you by Alessandro Dell'Endice, Carmine Lima, Denis Ayena Lorika, Kim Van Tittelboom, Neven Ukrainczyk, Saim Raza, Stijn Matthys, Thinh Nguyen and Yi Zhang.

European Innovation Council

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