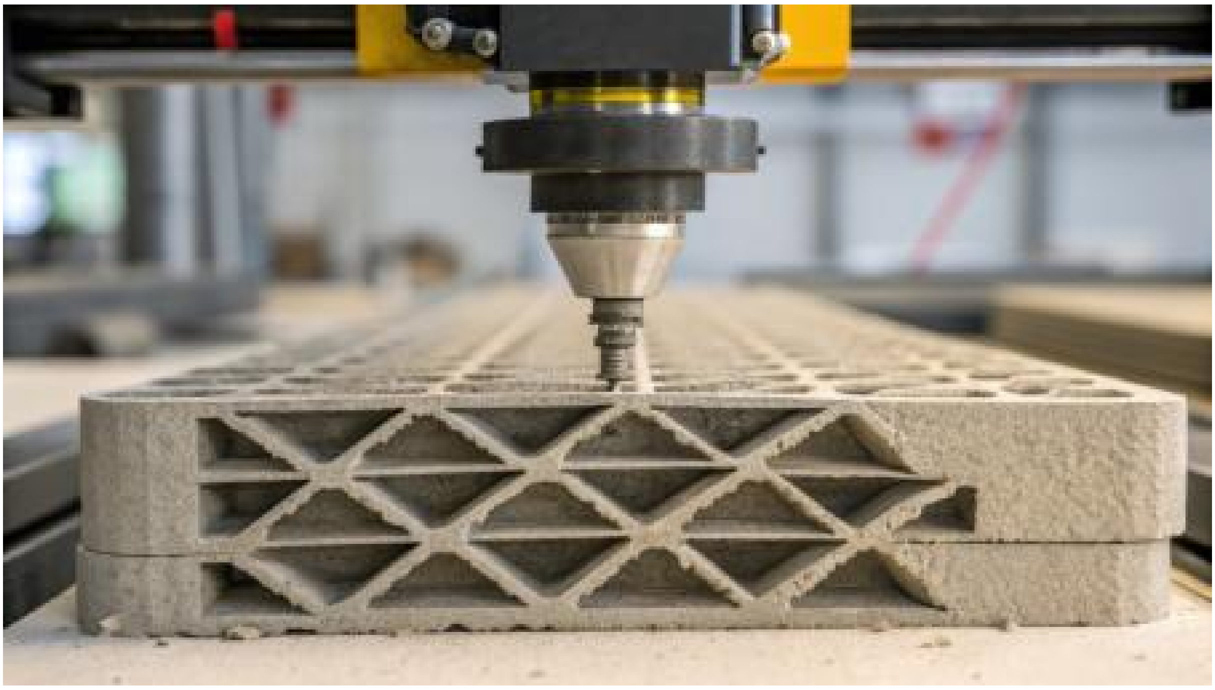
Optimising 3D concrete printing: Intelligent process control for higher component quality

About this project



inProAdd

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Markets:

Material: Others (Mortar)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

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Context

The construction industry is facing a variety of challenges: Complex building shapes, increasing demands on resource efficiency and the need to reduce emissions require new approaches to component manufacturing. Additive manufacturing processes - in particular extrusion-based 3D printing of concrete components - are seen as a promising solution. Extrusion involves forcing a material - such as mortar or concrete - through a nozzle under pressure. This creates a continuous strand that is built up layer by layer to form a component. This enables shape-optimised, material-efficient constructions without the costly use of formwork.

However, 3D printing with concrete also poses technical challenges: the fresh mortar must not only flow well, but also solidify quickly after leaving the nozzle and form stable layers. Inhomogeneities in the material and geometric deviations can jeopardise the quality of the components. Precise monitoring and control of the entire printing process is therefore necessary in order to be able to produce resilient, standard-compliant components and transfer additive manufacturing into industrial practice.

Purpose

The team working on the inProAdd project is developing an intelligent process monitoring and control system for the extrusion-based 3D printing of concrete. The aim is to significantly increase the quality of the printed components through continuous monitoring and automated adjustment during the printing process. The researchers want to record and analyse the properties of the fresh mortar, the dimensional accuracy and the physical properties of the layers in real time. In the event of deviations, the process parameters are to be adjusted immediately, for example by changing the mortar composition or the extrusion speed. With this innovative process control, the researchers want to make the 3D printing of concrete more stable and reliable in order to make it suitable for series production.

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Procedure

The scientists first set up a specially designed test rig that realistically reproduces the entire 3D printing process. Here, they test different mortar mixtures and process parameters using non-destructive testing techniques. During the printing process, sensors continuously record relevant data, such as the flow behaviour of the mortar and deviations in the layer geometry. A specially developed intelligent control system compares this data with target values and automatically adjusts the process control, for example by varying the material feed or printing speed. The project team utilises existing open-source software solutions for additive manufacturing and expands these to include building material-specific requirements. Finally, the team tests and validates the performance of the developed technology using a demonstrator: a wall structure is printed several times to show that the process can be reliably repeated. In doing so, the researchers check whether the intelligent process control enables consistently high component quality.

Funding duration:

Funding sign:	03LB5005	**Funding amount:**	EUR 475 thousand

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB5005 - inProAdd in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products	
Services & consulting	

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Lightweighting classification

	Realisation
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration Sensor technology	✓
Measuring and testing technology Non-destructive analysis	✓
Modelling and simulation	
Plant construction & automation Automation technology, Robotics	✓
Recycling technologies	
Manufacturing process	
Additive manufacturing 3D printing	✓
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Others (Mortar)	✓
Fibres	
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles	