Resource-saving modular houses: additive and automated production of concrete components

About this project

MHousePrintC

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Markets:

Material: Others (Concrete), Textile-reinforced concrete

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

Technology Transfer Program Leichtbau

Context

The demand for affordable and flexible living space is growing continuously. At the same time, the demands on the construction industry to use resources and energy efficiently and to recycle building materials are increasing. Smaller and modular forms of housing in particular are therefore gaining in importance. Micro and modular houses should take up little space, be energy-efficient to use and be as customisable as possible to meet different requirements.

Until now, such buildings have mainly been constructed using lightweight timber or steel. Although these construction methods allow for low weight, they often require a great deal of manual labour during production and assembly. They also reach their limits in terms of durability, sound insulation and moisture resistance.

Conventional precast concrete elements offer advantages here, but usually require complex formwork and consume a lot of material and energy, especially with customised geometries and small quantities. This is where the MHousePrintC project comes in.

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Purpose

The project team is developing an automated technology for the additive production of lightweight concrete-based wall and ceiling modules for modular houses. The modules should be load-bearing, thermally insulated and can be precisely fitted, as well as having a high level of production accuracy.

The researchers are concentrating on combining various manufacturing processes such as extrusion, injection moulding and casting technology within a digitally controlled process chain. At the same time, they are integrating built-in parts and technical functions during production. These include, for example, openings for windows and doors, empty conduits for electrics and sanitary technology, coupling elements or fastening systems for photovoltaic systems.

The project team aims to use less material and reduce greenhouse gas emissions by using cement-reduced concrete formulations, low-shell production and a force-flow-optimised design of the components. In addition, the partners are developing a recycling and re-use concept so that modules can be separated, reused or recycled by type after use.
The technology developed should not only be applicable to modular houses. Other possible applications include bicycle garages, heat pump cladding, rubbish bin boxes and technical enclosures.

Procedure

The researchers first develop a digitally configurable overall structure for modular buildings. From this, they derive customisable wall and ceiling elements as well as the associated production data. In the digital planning, they take individual geometries, technical installations and interfaces into account even before production.

At the same time, the project team is developing cement-reduced concrete formulations and mineral insulation materials for additive processing. The materials should be able to be processed using extrusion, injection moulding and casting processes and at the same time meet requirements for load-bearing capacity, thermal insulation and durability.

The partners will then trial combined additive manufacturing processes for the production of the modules. They are investigating robot-assisted processes, automated post-processing steps and precise joining technologies for wall, floor and ceiling elements. They are also integrating built-in parts, cables and fastening systems directly into the modules.

The project team validates the process chain using demonstrator modules and a model modular house. This is complemented by a "design for disassembly" approach that supports the dismantling, reuse and recycling of the modules.

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Funding duration:

Funding sign:	03LB1020	**Funding amount:**	EUR 479 thousand

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB1020A - MHousePrintC in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Baustoffwerk LIMEX-VENUSBERG GmbH

Lightweighting classification

	Realisation
Offer	
Products Parts and components, Materials	✓
Services & consulting Testing and trials, Engineering, Prototyping, Validation, Simulation, Technology transfer	✓

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Lightweighting classification

Field of technology	Realisation
Design & layout Lightweight manufacturing, Lightweight design, Hybrid structures, Lightweight material construction	✓
Functional integration Actuator technology, Media conductivity, Sensor technology	✓
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Materials analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Optimisation, Processes, Materials	✓
Plant construction & automation Automation technology, Robotics	✓
Recycling technologies Material separation, Recycling, Upcycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing 3D printing	✓
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining Hybrid joining, Adhesive bonding, Screwing	✓
Material property alteration	
Primary forming Extrusion, Casting	✓
Processing and separating Milling	✓
Textile technology	
Material	
Biogenic materials Others (Concrete)	✓
Cellular materials (foam materials)	
Composites Textile-reinforced concrete	✓
Fibres	
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles	