Increase dismantlability: Ceiling structures made of prestressed carbon concrete slabs

About this project

CPC-Leichtbau

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Markets:

Material: Carbon-fiber reinforced plastics (CFRP)

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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 construction industry contributes significantly to the consumption of resources and the release of climate-damaging emissions. It therefore plays a key role in achieving climate targets. There is potential for this in concrete and reinforced concrete construction in particular. Against this backdrop, carbon reinforced concrete construction is becoming increasingly important. The use of carbon reinforcement instead of conventional steel reinforcement enables slender and filigree concrete components, which saves material and improves the ecological balance. Carbon concrete also has a longer service life than reinforced concrete.

Furthermore, cost-effective alternatives to established construction methods are needed in solid construction that combine climate protection, resource efficiency and dismantlability and enable consistently high quality in production and assembly. One option is the combination of high-performance concretes with prestressed reinforcement based on carbon fibre reinforced plastic (CFRP). This results in slabs made of carbon prestressed concrete, or CPC slabs for short.

In addition to their optimised load-bearing capacity, CPC panels are characterised by their high durability. They can be produced in continuous format and assembled into lightweight components, for example for ceiling structures in building construction. In addition to dismantlability as the basis for reusability, modularity and flexible application options also play a role.

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Purpose

The team in the CPC lightweight construction project is developing designs for ceiling structures based on CPC panels. The participants are developing different structural variants and evaluating them with a view to minimising CO#, saving resources and full reusability. The project team is focussing on designs that support dismantlable and modular use in building construction. The project team is also aiming to reduce the use of non-degradable mortar and adhesives.

The project team is investigating the variants in terms of their load-bearing and deformation behaviour as well as the assembly and connection details and deriving a model for practical application. The participants are also producing demonstration components for a pilot project and using them for further investigations. At the same time, the project team assesses the design variants in terms of their ecological and economic sustainability.

Procedure

To begin with, the researchers carry out preliminary tests on the CPC panels used and determine the material properties under tensile, compressive and shear stress. The project team then draws up a test plan, works it out for components and connections and adapts and supplements it in the optimisation process. For the investigations, the project team carries out load-bearing tests on detail points and on overall components of the structural variants. It also analyses the components under service load and carries out fire tests.

At the same time, the researchers create numerical calculation models based on the material parameters and the design geometries. They calibrate the models based on the component tests and use them to model other geometries and load situations that cannot be captured experimentally. The project team uses the results to develop models for the mathematical description of the load-bearing behaviour and prepares them for practical application. Finally, the project team plans and realises load tests on a demonstration object, which the participants design, construct, assemble, load and dismantle together.

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Funding duration:

Funding sign: 03LB3112 **Funding amount:** EUR 1.3 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3112A - CPC lightweight construction in the federal funding catalogue

Project coordination

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English (EN){{ Projektpartner }}

Böll Bauunternehmung GmbH, Vetra Betonfertigteilwerke GmbH

Lightweighting classification

	Realisation
Offer	
Products Parts and components	✓
Services & consulting	
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration	
Measuring and testing technology	
Modelling and simulation Loads & stress, Materials	✓
Plant construction & automation	
Recycling technologies Material separation, Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining Adhesive bonding, Screwing, Others (Mortar)	✓
Material property alteration	
Primary forming	
Processing and separating Drilling, Milling, Cutting	✓
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres	
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles	