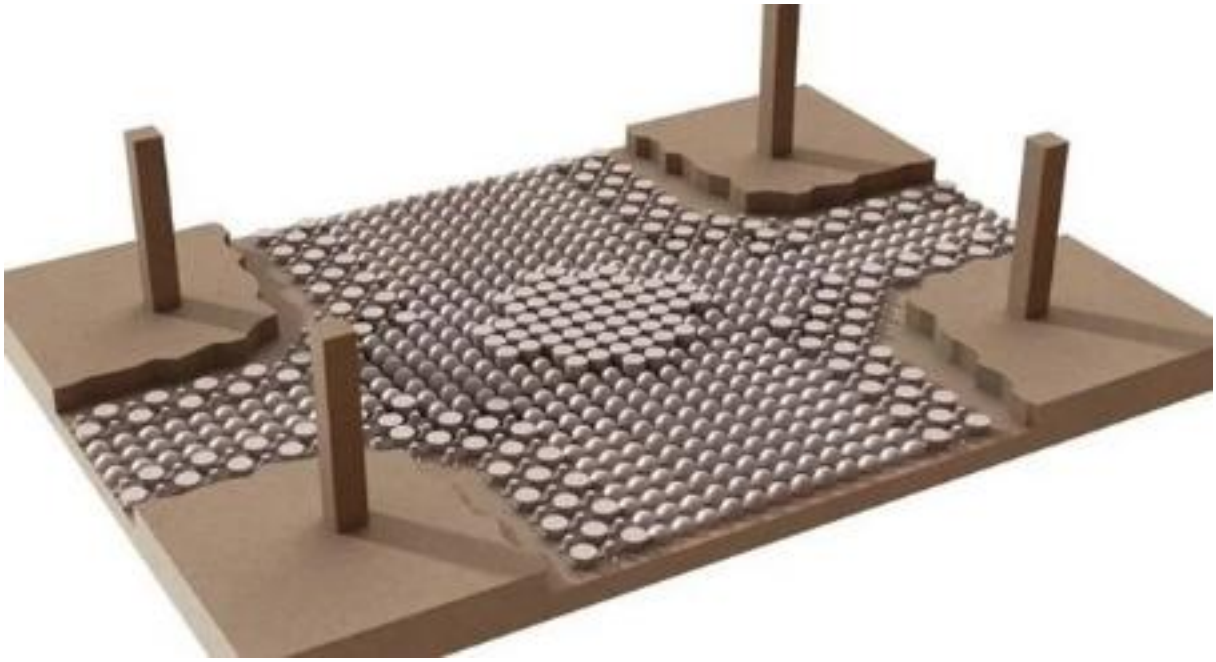
Less concrete thanks to inflatable hollow chambers: Designing foundation slabs more efficiently

About this project



air-Kon-Matrizen

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Markets:

Material: Woven fabrics, Others (Concrete)

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

Foundation slabs distribute the load of a building evenly over the ground. They are usually made of solid reinforced concrete and have a constant slab thickness. However, the load distribution on a foundation slab is inhomogeneous and so there are foundation areas that are of secondary importance for stability but are nevertheless solid. This leads to unnecessary consumption of resources and high CO# emissions.

For years, engineers have been using hollow bodies in floor slabs in order to use concrete only where it is required for the load-bearing capacity. This lightweight construction technology could not previously be applied to foundations. This is because their large slab thickness also requires large-volume hollow bodies. The production of such elements by injection moulding as well as their transport and installation are uneconomical. A research team is now closing this gap - with a practical, resource-saving solution specifically for foundation slabs.

Purpose

In the air-Kon matrices research project, the project team is developing inflatable hollow chamber matrices for concrete foundations. The aim is to reduce concrete consumption where the building material is not required for the load-bearing capacity. The partners are using textile hollow bodies as concrete displacement bodies for this purpose. These allow a flexible geometric design. The appropriate shape and size can be selected for each foundation position depending on the respective load condition in order to displace the maximum possible volume of concrete. The textile hollow bodies can be transported to the construction site in a space-saving manner and are inflated there at their respective position.

The researchers want to save up to 40 per cent of concrete in this way - more than is currently possible in comparable ceiling applications. At the same time, CO# emissions during construction are significantly reduced. The technology can be applied to almost any building.

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Procedure

The project team is developing various hollow core types that can be specifically adapted to the loads in the foundation slab. To do this, the researchers are analysing typical combinations of bending moments and shear forces. With the help of "genetic programming", an optimisation method from computer science, a digital catalogue of optimised hollow core shapes for different load conditions is being created. Based on this catalogue, the project team uses topological optimisation methods to develop a generally valid method for arranging the individual hollow chamber matrices in foundation slabs. This enables the team to select the appropriate moulds for each project.

The moulds are made of technical textiles, are easy to transport, can be installed in the formwork and inflated directly on site. The load-bearing capacity of slabs with the innovative, inflatable hollow moulds was verified in component tests and numerical simulations. At the same time, the project partners are digitising the entire planning, production and installation process for foundations with hollow chamber formliners. This should, for example, enable simple integration of the new hollow bodies in planning (BIM connection) and allow the moulds to be manufactured economically in series despite their individual geometry.

The project team is also developing an app with integrated assembly instructions in an AR environment to ensure that the moulds are installed in the correct position on the construction site.

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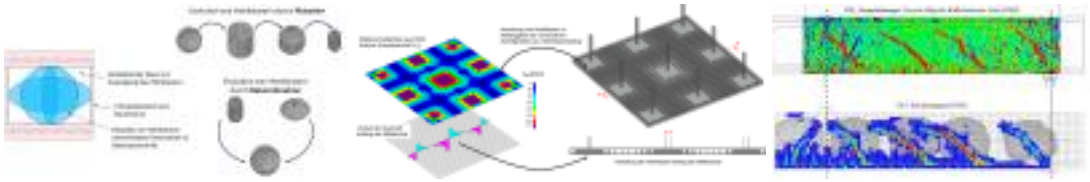

Funding duration:

Funding sign: 03LB2042

Funding amount: EUR 1.3 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2042A - air-Kon matrices in the federal funding catalogue

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Project coordination

Contact:

Mr Dr.-Ing. Falko Vogler

+49 7443 12 6902

falko.vogler@fischer.de

Organisation:

fischerwerke GmbH & Co. KG

Klaus-Fischer-Strasse 1
72178 Waldachtal
Baden-Württemberg
Germany

www.fischer.de

English (EN){{ Projektpartner }}

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Lightweighting classification

	Realisation
Offer	
Products Parts and components	✓
Services & consulting Consulting, Testing and trials, Engineering, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight manufacturing, Lightweight design	✓
Functional integration	
Measuring and testing technology	
Modelling and simulation Loads & stress, Optimisation, Processes	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Casting (concrete)	✓
Forming	
Joining Welding	✓
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 (Concrete)	✓
Fibres	
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles Woven fabrics	✓