

### **3D concrete printing**

#### **Scientists at TU Dresden develop 3D printing method using concrete**

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Concrete is one of the most important building materials in the modern world. Concrete structures and components are extremely varied, and so too are their forms, material composition and production processes. Around the world, more than half the volume of concrete produced is processed directly on building sites in the form of cast-in-place concrete. However, the usual method of working with cast-in-place concrete requires a large workforce and considerable time and expenditure for scaffolding and formwork. In many cases, formwork systems have to be adapted to the specific characteristics of the site. This results in immense consumption of valuable resources and high labour costs. These disadvantages have encouraged the development of a completely new building method based on continuous, formwork-free construction technology. A possible means of avoiding the aforementioned shortcomings in the future is to construct buildings using additive production processes.

Additive production processes such as 3D printing have been adopted in nearly all industrial sectors in recent years, since they offer an exciting and almost unlimited array of potential applications in an impressive range of different materials. Diverse efforts to transfer this production technology into the building sector can currently be observed all around the world, particularly in the sphere of prefabricated concrete components.

A team of scientists at TU Dresden (Dresden University of Technology) is currently developing a technology that is intended to bring 3D printing directly onto building sites. The key feature of the method is the layer-by-layer extrusion of a fast setting special concrete mix from a print head nozzle. The print head nozzle is guided with geometrical precision by a large-scale robot. The entire process is controlled via data types which contain mainly geometrical and material data and which are generated on the basis of specially prepared building models. The characteristic features of this project are as follows:

- The 3D concrete printing process is conducted directly on the building site.
- The building material used is a fast setting concrete which meets the high standards required for its processing and which is at least equal in quality to conventional materials with respect to its concrete technological properties.
- The large-scale robotic system for the automated movement of the print head nozzle is based on established construction machinery, such as truck-mounted concrete pumps. With small modifications, these can be used for the new technology but can still be used in their original way as well. The new building method can therefore be easily integrated into traditional construction operations.

- The new concrete construction technology is fully integrated into the overall building process, from the planning stage to the finished shell of the building. The data structures required for 3D concrete printing are generated during the planning phase, and in the execution phase they serve to control and monitor the large-scale robotic system. Taking account of construction management aspects, this can help to optimize the construction process.

As part of a research project funded under the “Zukunft Bau” research initiative of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), scientists from three institutes at TU Dresden are currently working on a feasibility study concerning 3D concrete printing. Building upon the knowledge gained so far, further follow-up projects are planned which aim to continuously improve concrete materials and machinery in order to develop a functional demonstration prototype.

If 3D concrete printing technology is used to construct whole buildings in future, this technology may significantly reduce building costs thanks to material savings and increased productivity. Furthermore, this additive production process provides architects with a completely new range of opportunities for designing buildings, so that this technology has the potential to revolutionise not only construction processes but also structural forms.

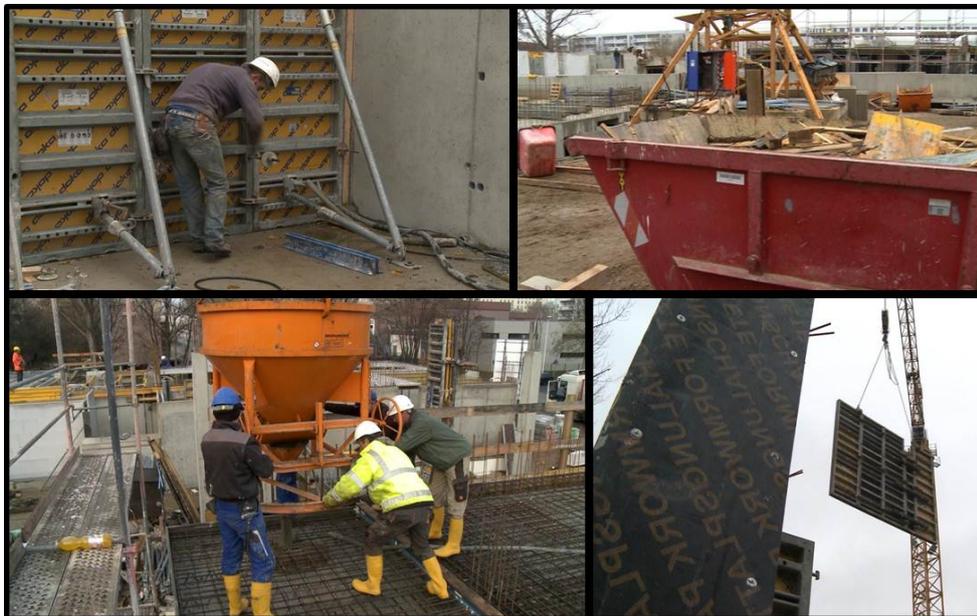


Fig. 1: Conventional working with cast-in-place concrete and formwork



Fig 2: Laboratory tests for 3D concrete printing

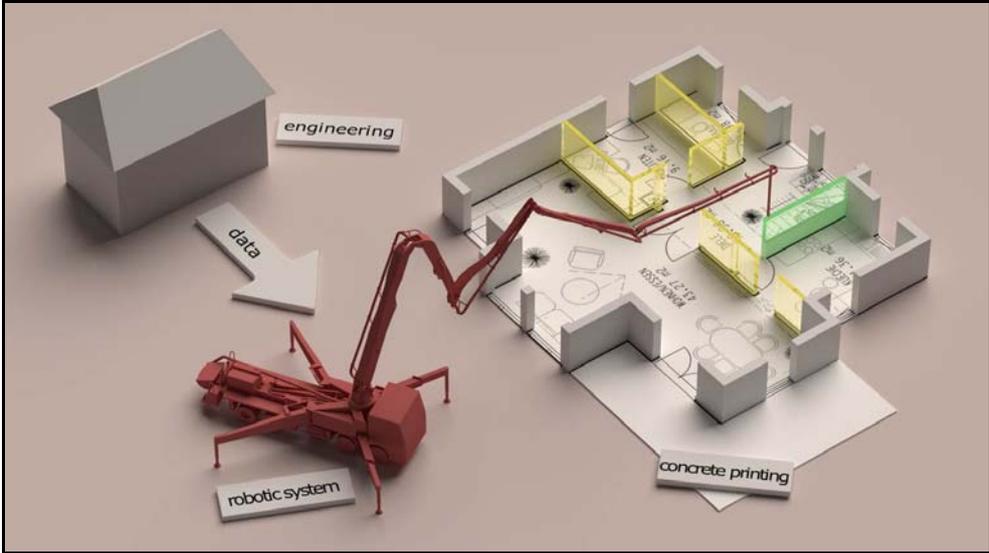


Fig. 3: Essential elements of the new technology

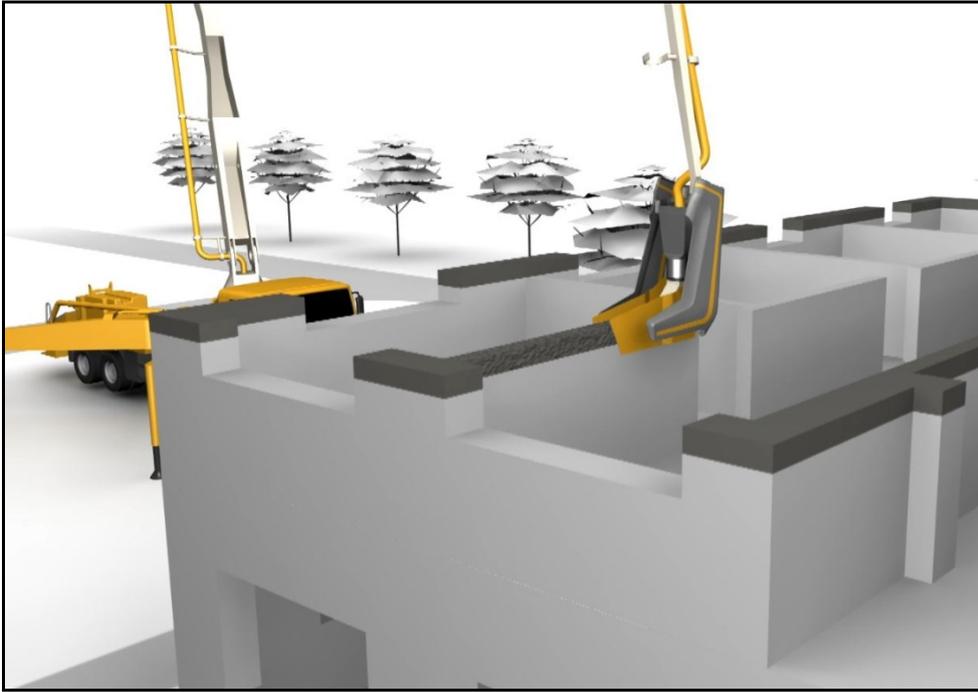


Fig. 4: 3D concrete printing on the building site