Kniele GmbH, Bad Buchau, Germany

Mixing plant for 3D concrete printing at the Digital Building Fabrication Laboratory (DBFL) at Technical University Braunschweig

The increasing digitalisation and automation in the construction industry is placing new requirements on concrete production and processing. In the field of additive manufacturing in construction, particularly the Shotcrete 3D printing process, reproducible recipes, short reaction times and precise coordination between the mixing, pumping and printing processes are crucial for building components layer by layer. Against this background, a mixing plant specifically designed for 3D concrete printing was developed for the Digital Building Fabrication Laboratory (DBFL) in a collaboration between the Institute for Structural Design at Technical University Braunschweig and Kniele GmbH.

Project progress and technical challenges

The initial discussions regarding the design of the plant aimed to develop a compact, versatile mixing plant that would meet the specific requirements of the Shotcrete 3D printing process whilst also being able to be integrated into the laboratory's existing infrastructure. The existing structural condition was then recorded using a detailed 3D scan. This assessment formed the basis for further planning and enabled the plant technology to be precisely adapted to the available space. The very limited space in the existing building posed a particular challenge. In addition, an existing

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pit had to be bridged, which required a specially designed support structure for the mixer platform. Another complicating factor was the low available height, due to the existing overhead crane. Once the contract had been awarded, work began on the engineering design and the production of the plant components. Despite these boundary conditions, a compact and maintenance-friendly arrangement of all components was achieved. Finally, assembly, commissioning, extensive testing and initial printing tests were carried out.

System concept and technical equipment

Binders are supplied via a triple big-bag station, with each station equipped with its own buffer silo. All big bag stations are filled via a shared electric chain hoist, resulting in a particularly space-saving and cost-optimised solution. The raw materials are transported to the cement scale via screw conveyors, ensuring continuous feeding and precise dosing.

At the heart of the plant is a Kniele KKM 375/550 cone mixer, fitted with a flap for the sealed transfer of concrete into a secondary silo and subsequently to the concrete pump. The mixer is supplemented by a forced dust extraction system, which ensures clean operating conditions, particularly with fine-grained recipes.

The complete control system and the power unit were supplied by Bikotronic. This allows the concrete formulation to be digitally controlled and dynamically adjusted.

The Shotcrete 3D printing process allows for great freedom in the geometry of precast concrete elements. Single- and double-curved reinforced components can be produced in the DBFL without formwork.

For the liquid components, a water dosing system with coarse and fine dosing has been installed, ensuring high dosing accuracy. The admixture weigher is supplied by Würschum and is fully integrated into the plant control system. The complete control system and the power unit were supplied by Bikotronic and enable digital control of the concrete formulation and mixing parameters, which is of central significance for a reproducible printing process.

Below the mixer is the secondary silo, which serves as a buffer for a continuous pumping and printing process. The existing concrete pump was modified as part of the project and fitted with an extension hopper including an agitator, and it conveys the finished material to the robot. This ensures a consistent material flow from the mixer through the pump to the print head.

Integration into the printing process

The system is specifically designed for the Shotcrete 3D printing process. The close integration of the mixer, secondary silo, pump and print head enables a continuous flow of material whilst ensuring high process reliability. Differences in consistency or flow behaviour can be detected and adjusted immediately via the control system of the mixing plant and print head.

Collaboration and project participants

The design and implementation of the plant took place in close technical consultation with the project partners at Technical University Braunschweig. Communication took place in particular with Dr Jeldrik Mainka, Prof Harald Kloft and Prof Dr Dirk Lowke, who is now based at the Technical University of Munich. The constructive collaboration, the continuous exchange of ideas and the high level of commitment from all participants were crucial to the successful completion of the project. ■

FURTHER INFORMATION

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