

3D-Printed Bridge at the Technical University of Darmstadt

In the summer semester of 2024, an innovative six-meter-long bridge was realized at the Technical University of Darmstadt as part of the "Constructive Design Project" course at the Institute for Structural Design and Building Construction, as well as in the Facade Technology Department. This project utilizes state-of-the-art 3D printing technologies in combination with traditional woodworking techniques.

The bridge is based on a design featuring a hybrid construction of 3D-printed concrete and CNC-manufactured wood. The 3D-printed concrete components were developed and manufactured in close collaboration with the leading construction chemistry company Sika Deutschland GmbH (supported by Dr.-Ing. Slava Markin, Dr.-Ing. Shifan Zhang), Staikos 3D GmbH (led by Managing Director Georgios Staikos), itsfis UG (led by Yannik Berkensträter), the engineering group Bauen, and Prof. Dr.-Ing. Michael Kraus from the ISMD Institute. This process included selecting suitable concrete mixtures, developing specific printing methods, and conducting test prints and trials in the labs of TU Darmstadt to ensure the highest execution quality.

Simultaneously, two flat wooden beams made of laminated wood panels were fabricated using precise CNC techniques. The production of these components took place in the woodworking shop of TU Darmstadt. After the components were completed, the bridge was assembled, with a strong focus on the close coordination between planning and execution.

A key aspect of the project was digital planning and optimization. For example, the concrete cross-section was adjusted using a parametric optimization algorithm to maximize material efficiency and evenly distribute stresses. Various cross-section sizes and shapes were also analyzed for the wooden beams to create a delicate yet highly loadbearing bridge structure.

Another highlight of the bridge is the aesthetically pleasing interplay of concrete and wood, emphasized by ornamental milling and precise notches in the wood for weight reduction. These features allow for the exact assembly of the concrete modules, which could be securely and modularly joined through intelligent design.

The project impressively demonstrates how traditional materials can be combined with modern technology to create innovative and functional structures. It also highlights the importance of precise digital planning in all phases of construction to ensure optimal implementation. The successful realization of this bridge marks a milestone in education at the Technical University of Darmstadt and serves as an example of pioneering construction methods. Thus, the project makes a significant contribution to the practical training of students and the promotion of innovation and technology in construction.

Project Participants:

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