Zukunft Bau

SUMMARY

Title

Temporary modules of high performance concrete with detachable connections

Motive

Architects and engineers develop a module system for multi-functional removable modules, for which different connector systems and concrete elements are to be investigated numerically and experimentally.
The result is a test and proof program to be written for the connectors and elements that can serve as a basis for obtaining a building approval or an approval in individual cases.

Aim of the research project

The resulting problems were solved jointly by the three applicants. The procedure was as follows:

A total of four different module systems were designed at the start. Three of them as part of a student project. A fourth system was designed by Bayer and Schluppkotten. For this system a prototype was to be built. For all four module systems several parts were constructed on a 1:1 scale to demonstrate the practicality with the respect to production and assembly.

In a second step numerical investigations on different module variants were carried out. The internal force variable and reaction were determined on a test element that can be used as both wall and ceiling and the elements were designed. Next, three variants of the module Bayer/Schluppkotten (B/S) system were investigated numerically and the decisive stresses of the connector were filtered out.

Another part of the project included experimental investigations of the connecting system and the concrete elements. Three connecting systems, a bolted connection with coupling element, one without and a so-called turnbuckle connection, were subjected to stress at different levels until failure and in the process the stress-slip relationship and the flexibility were investigated. The three connecting systems can all be disconnected and re-used but are also durable. They are functional and load-bearing, and this was confirmed in the tests.

A test program was derived from these tests, such as would be necessary for obtaining building approval. It envisages loading the connection at first always in only one load direction. This provides the stress resistance capacities in the event that either only a normal force or one of the lateral forces would be effective. In further tests the connecting systems are to be stressed in all three directions. The ratio of the forces should be selected in the least favorable way, which would mean that, in the least favorable case, all three measurement loads would be equally great. The loads are as far as possible to be brought up simultaneously and in the ratios investigated previously. The test results can finally be plotted graphically in interaction diagrams. From the load bearing capacities of the tests the rated values of the resistances are to be determined with an appropriate statistical evaluation, which can also be illustrated in interaction diagrams.

In addition, one of the wall elements with side supports was loaded in a negative pressure test stand to breaking. The acceptable area load of around 10 kN/m^2 was thus well over what can practically be expected in stress terms. The wall element is only 1.5 cm thick. Reinforced with 4 layers of steel wire mats, a so-called micro-reinforcement. The surrounding marginal rib was reinforced with bars with 6 mm diameter.

A test program was also suggested for load-bearing thin-wall concrete elements, which would allow building approval to be obtained. The ribs, at least in terms of the curvature, can be measured following the valid reinforced and accounted for.

The planned construction of the prototypes is not yet complete. At the moment the final parts of the formwork and mounting parts are being produced for the prototypes in the workshops of the TU Kaiserslautern. The concrete elements are to be produced in the course of the year by the Fehr company. The prototype will then be constructed and professionally photographed on private property. In this context there will be tests for windproof and waterproof (heavy rain) soundness.

Conclusion

The two main goals of the research project presented at the beginning, the development of multi-functional module systems and the design of a test procedure as the basis for obtaining building approval, both for the connecting systems and the filigree components of high-performance concrete, have been achieved and the related working steps completed.

After the prototype is ready, the project is to be submitted for architectural competitions and published in the specialist journals. In this way the largest possible circle of architects may find this technology interesting and be inspired to use it in their buildings.

Basic data

Short title: Modules with detachable connections

Researchers/Project management:
Dr.-Ing. Christian Kohlmeyer, Prof. Dipl.-Ing. Dirk Bayer, Prof. Dr.-Ing. Jürgen Schnell

Total costs: 131,626 €

Amount of Federal subsidy: 76,990 €

Project duration:
36 months (originally 18 months, cost-neutral running time extension by 18 months)

IMAGES/FIGURES:

fig.1: RZ_Bild 1.jpg
Visualization of a module of the Bayer/Schluppkotten system

fig.2: RZ_Bild 2.jpg
Section model on a scale of 1:1 of the Bayer/Schluppkotten system

fig.3: RZ_Bild 3.jpg
Connecting system 1 in load capacity test

fig.4: RZ_Bild 4.jpg
Turnbuckle of the connecting system 2

fig.5: RZ_Bild 5.jpg
Wall element in negative pressure test shortly before reaching load capacity

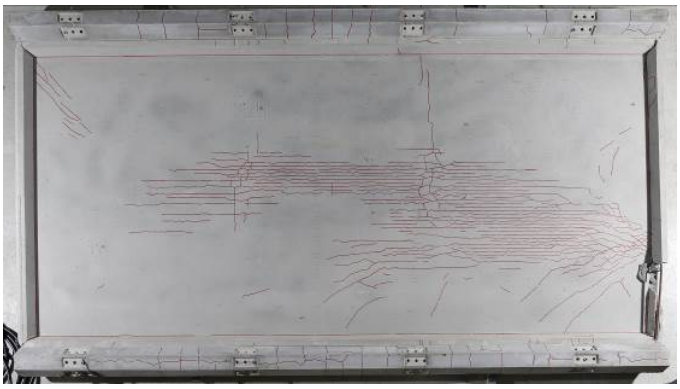

fig.6: RZ_Bild 6.jpg
Lower side of a wall element with crack pattern after negative pressure test