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BUIDLING BRIDGES USING LIGHTWEIGHT BRIDGE GIRDERS OUT OF CONCRETE

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Abstract

The Institute for Structural Engineering of the Vienna University of Technology has been working on a construction method for lightweight precast concrete bridge girder that would enable concrete to become an attractive alternative option to steel when it comes to the construction of bridges without formwork. The main idea consists of using precast elements in collaboration with in-situ concrete in order to create lightweight box-sectioned bridge girders that could easily be handled during transport and mounting. In large-scale tests, two bridge girders were built and tested. It could be shown that the tested cross sections had enough stability to be transported and installed with ease on the construction site. After the positive results of the large-scale tests two bridges were designed using the lightweight bridge girders. The focus point of the design and calculation were the different construction phases. The girders of the two bridges would be built in nine construction phases, whereas the first three phases would be constructed using formwork and the remaining six phases using the lightweight precast concrete bridge girders. The post-tensioned girder sections, with a maximal length of 60.4 m, would be assembled near the construction site, subsequently transported to the site by ship and lifted into position using a crane, permitting a rapid progress in construction.

Keywords: Bridge engineering, design, detailing, large-scale testing, posttensioning, precast

1 Large-scale testing

Large-scale tests were conducted to provide valuable insight into the building process and stability of lightweight box-sectioned bridge girders out of concrete. Furthermore, the construction accuracy of the precast elements was verified by measuring and weighing the entire girder. Two box-sectioned bridge girder, with a height of 2.89 m and a width of 6.00 m (Fig. 1), were built and tested (Fig. 2). The results confirm that the box-sectioned girders, which were designed and built for the experiments, have enough stability to be transported and installed but will need extra support while the deck slab is being cast. With the results of the two tests a static calculation model, was calibrated to allow reliable prediction for further examinations of cross-sections with variable dimensions.

Fig. 1 Completed lightweight box-sectioned bridge girder out of hollow wall elements and ultra-thin precast elements.

Fig. 2 Test setup

2 Designing bridges using lightweight bridge girders

Following on from the favourable experience gathered in the production and testing of the lightweight box-sectioned bridge girders it was decided to participate, in close collaboration with the engineering office FCP – Fritsch, Chiari & Partner ZT GmbH, in a competition for the construction of two bypass bridges for the Voest bridge across the Danube river in Linz, Austria. Due to the fact that the construction process with the prefabricated elements differed in many aspects from a conventional construction method, the building phases strongly influence both the designing, planning as well as the calculation process. One of the first steps of the designing process was the adaptation of the cross-section of the lightweight box-section concrete girders (Fig. 3). The total span of 407 m was divided into 6 spans with a main field length of 107 m. The girders of the two bridges would be built in nine construction phases, whereas the first three phases would be constructed using formwork and the remaining six phases using the lightweight bridge girders. The girder sections, with lengths between 20.5 m and 60.4 m and weights between 140 t and 440 t, would be assembled near the construction site and then subsequently transported to the site by ship and lifted into position using a crane.

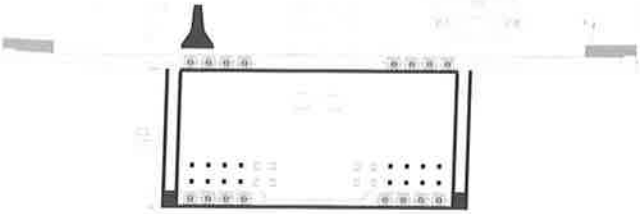

Fig. 3 Standard cross-section for the bypass bridges over the Danube river in Linz. (FCP 2014).

3 Conclusions

By using the lightweight box-sectioned concrete girders in the design of the bypass bridges for the Voest bridge in Linz, Austria, it could be shown that the elements are able to compete with conventional bridge construction methods and can be seen as an alternative option to steel girders. Even though the results of the design competition of the bypass bridges for the Voest bridge did not go in favour of the design using lightweight bridge girder the entire design and planning process showed that this building technique is not to be overlooked.

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FCP – Fritch, Chiari & Parnter ZT GmbH (2014), A7 "Bypass"-Brücken zur Voestbrücke über die Donau – Technischer Bericht. Anonymously submitted documents for the design competition: A7 "Bypass"-Brücken zur Voestbrücke über die Donau.