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CABLE-STAYED FOOTBRIDGE WITH UHPC DECK IN CELAKOVICE

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Summary

The cable-stayed footbridge over the Labe River in Celakovice is the first structure in the Czech Republic which has a superstructure made of UHPC. The design and the execution of the footbridge were based and verified on experimental testing of the new material. The design is at some parts conservative due to the limited knowledge on the performance of the UHPC. The UHPC (ultra-high performance fibre reinforced concrete) was developed by the team of Metrostav and TBG Metrostav from 2010 on both for precast as well as for in-situ cast structures. Local materials are used preferably. The contractor Metrostav implemented an alternative proposal of a segmental bridge deck made entirely of UHPC class C130/150 with steel fibre reinforcement instead of the composite deck proposed in the tender. The arrangement of spans is 43+156+43 m. The application of UHPC for the deck resulted in a smaller weight for the footbridge. The stays and pylons are then also rather light. The design and final appearance is extremely simple and efficient. The UHPC should become a guarantee of the long term durability of the footbridge (more than 120 years is expected), with a limited maintenance. Extensive loads and dynamics tests were provided as well as environmental assessments.

Keywords: cable-stayed footbridge; durability; efficiency; prefabrication; segmental construction; UHPC; dynamics; sustainability

1. Introduction

The experience from the research and development of UHPC has been utilized in design and implementation of several bridges in the Czech Republic. The cable-stayed footbridge over the Labe in Celakovice is the most significant achievement among them.

2. Structural system of the Celakovice footbridge

The footbridge in Celakovice is connecting the town on the left bank of the Labe River with a popular recreational area on the right bank. It enables comfortable river crossing for pedestrians, cyclists and emergency vehicles. In the tender documents, a cable-stayed footbridge with a composite superstructure consisting of two longitudinal side beams of welded steel profiles, steel cross beams and a concrete slab was designed. The composite slab was designed from precast concrete elements of C110/130 with steel fibre reinforcement. The elements were supported on the bottom flange of the side beams and cross beams. After assembling all gaps between the slabs and steel beams should be filled with in-situ cast concrete. The contractor proposed an alternative solution of a segmental bridge deck with the arrangement of spans 43+156+43 m (Fig. 1) made entirely of concrete C130/150 with steel fibre reinforcement (Fig. 2).

Steel pylons with a total height of 37 m are shaped like the letter A and they are fixed on the foundation blocks on in-situ cast piles. Stays are arranged in two planes, the lower adjustable anchorages are located

on the side of the deck. The deck is supported by fully locked cable-stays with galvanisation corrosion protection. Abutments on both river banks are massive reinforced concrete blocks on piles that form a counterweight to uplift reactions of the superstructure. The walkable surface of the deck is covered by sprayed waterproofing of a 5mm thickness. The steel railings 1.3 m high have integrated lighting.

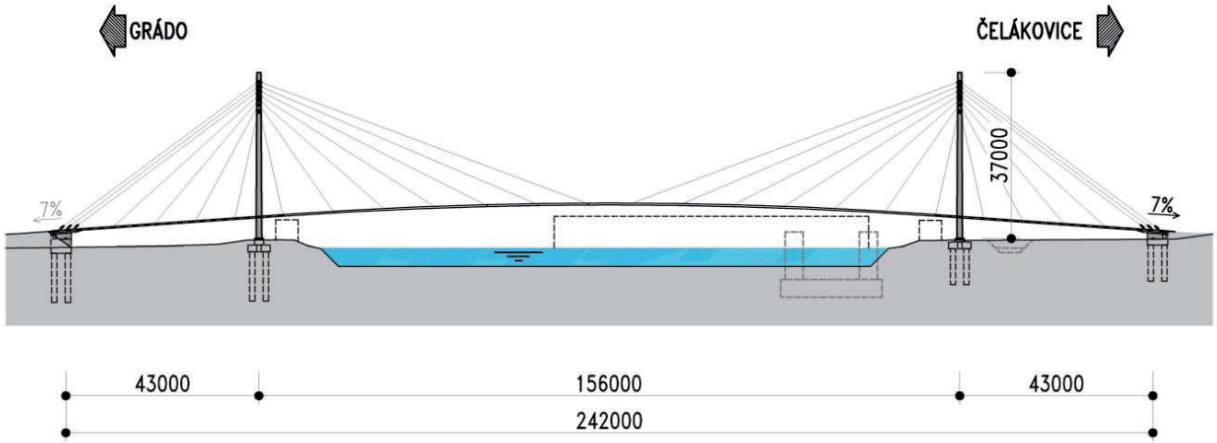

Fig. 1 Longitudinal section

In the original tender design the distance of 11.3 m between the stays was fixed. Therefore, segments were cast in two steps, the joint between them being reinforced. The segmental joints were glued with epoxy resin. A special launching gantry was used for the assembly of the superstructure. A detailed analysis model was prepared including the launching gantry movements, stressing and removal of temporary cables, adjustment of forces in final tendons etc., resulting in approx. 120 stages. The analysis included the effects of nonlinear behaviour of the structure caused by varying stiffness of stays due to their sag.

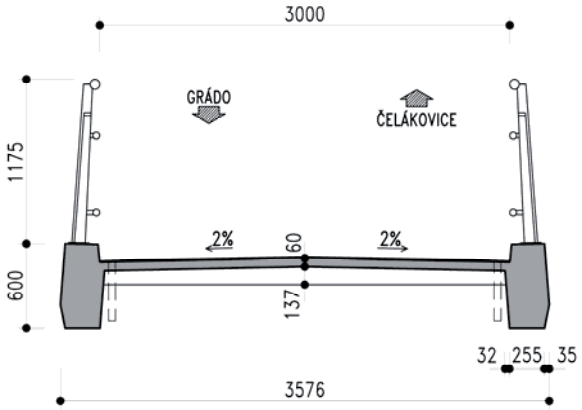

Fig. 2 Cross-section

3. Conclusions

The footbridge over the Labe River in Celakovice is the first structure in the Czech Republic with an entire superstructure made of UHPC. The design and the execution of the footbridge were based on experimental experience with the new material. The design of some parts is conservative due to the limited knowledge on the performance of the UHPC. The application of UHPC for the deck resulted in a smaller weight of the footbridge. The stays and pylons are also rather light. The UHPC should guarantee long term durability of the footbridge, with low maintenance required.

The Celakovice footbridge received several national awards and also the 1st place in the ACI Excellence Awards 2015 in the category of infrastructure and 2nd place in the ECSN European Concrete Award 2016 in the category of civil engineering.

Following good practical experience Czech recommendations for the material specifications, design, testing and execution of precast structures made of UHPC in the Czech Republic were drafted and later approved by the Ministry of Transport in 2015.

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