The construction of long span footbridge over Vistula river in Cracow

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Summary

The new footbridge over Vistula River recently built in Cracow spans two riverbanks in the historical city centre, what strongly influenced the architectural shape, structural solutions and construction technology of the footbridge. This is the 148 m long tied arch steel structure with one main arch girder of circular cross section and twin suspended orthotropic steel decks covered with timber planks. The most challenging part of the project was the bridge assembly and erection. The Vistula River needed to remain open during construction because it serves as a navigation channel for tourist fleet and so conventional methods of construction were questioned. The footbridge was horizontally rotated across the river from its construction site on the right bank into its final position on abutment on the left bank. The paper has briefly described the new footbridge, its structural solutions as well as the unusual technology used for the construction, i.e. horizontal rotation method.

Keywords: construction technology, horizontal rotation, footbridge, steel arch, tied arch.

1. Introduction

Rotation construction method comprises building a bridge parallel to the obstacle and rotating the superstructure into place. The method can optimize bridge construction in terms of reducing impacts on traffic or navigation, safety, and overall project budget and duration. Therefore the method became so popular and it has been used successfully all over the world. The first use of this method in Poland has been presented in the paper.

In June 2006 Cracow Municipality invited bids for international tender on a footbridge over Vistula River, connecting two old city quarters. The winner proposal prepared by the Polish architect A.Getter presented key features, which had to be included in final design, f.e. low rise arch and split deck with leaf-like cross-beams/stringers skeleton and old stone masonry abutments incorporated into new footbridge. The structural design and the construction technology prepared by the authors for the contractor, preserved the architectural form and geometry, but adapting structure and its erection to site limitations [1]. In the paper the structure as well as the untypical construction technology have been briefly described.

2. Footbridge structure description

The footbridge is 148 m long tied arch steel structure with one main arch girder of circular cross section and twin suspended orthotropic steel deck covered with timber planks. With the arch radius of R=170 m and the rise of 15,3 m, the structure is very slender with H/L = ~1/10. The twin steel deck is suspended to arch girder by hangers with network arrangement. The network system for hangers along with horizontal bracing in deck level increased significantly the spatial stiffness of the span (Fig.1). Additionally the steel deck is also fixed to RC abutments. With regard to very bad soil conditions it was necessary to minimize the horizontal load acting on foundations. The horizontal load was substantially decreased with the tie, which carries the part of thrust generated by dead loads. The abutments are founded on a set of 10 bored piles with the length of 17-18 m [1].

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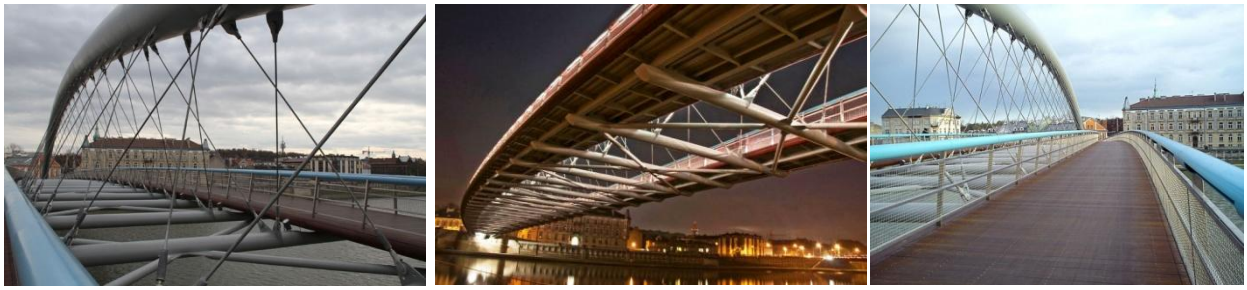

Fig. 1: The footbridge structural solutions

3. Construction technology

The most challenging part of the project was the bridge assembly and erection. It was decided to assemble the whole span on the right bank of Vistula River and to rotate it horizontally as a rigid body with help of floating support into its final position. The span assembly location was chosen along the right river bank, and the construction site was adjusted to further rotation of the span. The arch girder and the deck were assembled on auxiliary columns. After assembling the steel span, hangers and the tie were initially tensioned following auxiliary columns removal (Fig.2).

Fig. 2: The arch girder and deck assembling on auxiliary columns

The final step of the erection was the spectacular rotation by ninety degrees to the final position (Fig.3). The total weight of rotated span was about 700 tons. The bridge rotation operation took place in only 6 hours, during which time river boat traffic was completely stopped. The average speed of rotation was 2 m/min. The force needed to shift the span into floating support was about 600 kN, and for rotating – only 50 kN.

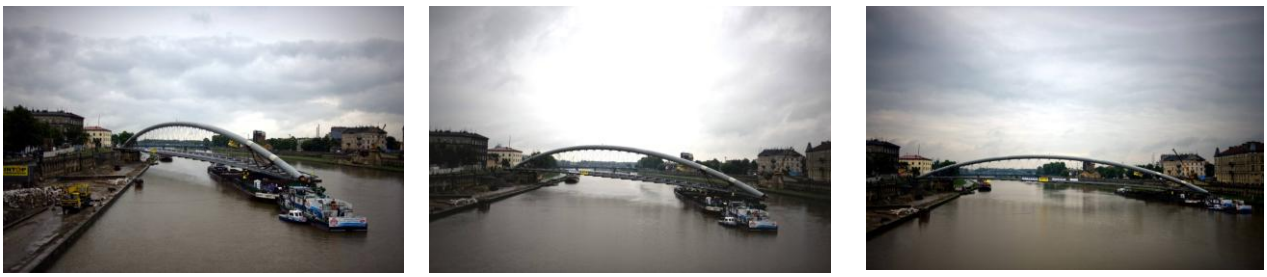

Fig. 3: The view of span rotation

The horizontal rotating method applied for construction of the footbridge over Vistula River in Cracow proved the high economic efficiency of the project. Owing to applied erection method the whole construction time of footbridge was considerably shortened which has brought the benefit for contractor.

4. References

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