RECONSTRUCTION OF THE OLD SOUTH JAGIELLONIAN ARCH BRIDGE OVER CHANNEL OF THE ODRA RIVER

J. Rabiega[1], M. Kożuch[1], W. Lorenc[1], D. Śmiertka[2], P. Wątroba[2], R. Wodyński[3]

[1]Department of Civil Engineering, Wrocław University of Technology, POLAND.
[2]MOSTY, Ramiszów, POLAND.
[3]Tarcopol Sp. z o.o., POLAND.

e-mails: jozef.rabiega@pwr.wroc.pl, maciej.kozuch@il.pw.edu.pl

SUMMARY

In the paper authors presented general overview on the reconstructed road bridge over the flood canal of the Odra river in Wrocław. Overall parameters of the bridge are indicated and interesting details of the bridge are shown. Authors described also assumptions for finite elements calculations, which were carried out in accordance to PN-S standards. The large scope of reconstruction was the reason of the lack of maintenance works throughout last 30 years combined with non-durable solutions of previous designs, especially using a concrete deck on Zores sections. Performed works should guarantee safe exploitation of the bridge in the next decades.

Keywords: *Riveted bridge, reconstruction, arc bridge.*

1. INTRODUCTION

The present bridge is a structure operated by 90 years, which is the last major overhaul passed in 1984. Since that time, mainly due to the leaking isolation platform, developed progressive corrosion surface and pitting the whole supporting structure of the bridge below the surface, and therefore the whole bridge, especially in its bottom part of superstructure. There are also local damage resulting from impact of vehicles during collisions. All this damage led ultimately to exclude an object of exploitation, until the time of repair.

2. FEATURES AND SCOPE OF REPAIR FACILITY

Of the many road bridges in Wroclaw, described here, the bridge stands out in a special way. The object called today South Old Jagiellonian Bridge is constructed with girder arch with a brace. For many decades, it layed on the national road no. 8, which is the outlet of Warsaw, and is now in a two-lane avenue Jan Kochanowski. This bridge was built in 1925 in the framework of reconstruction of Wroclaw Floodway after the flood of the century 15/07/1903, when it was built to the north of Wroclaw Navigable channel and channel flooding dating from the years 1913 to 1917 (ie. The Oder II sewer). Scheme existing bridge shown in Fig. 1 and a cross-section in Fig. 2. As the material construction of the span, determined on the basis of laboratory tests of samples taken steel species ST2SX according to PN-72 / H-84020. For the assessment of the current capacity of the structure, designed yield stress at R = 182 MPa is assumed. Bridge was calculated and designed with standard PN-S-10052.

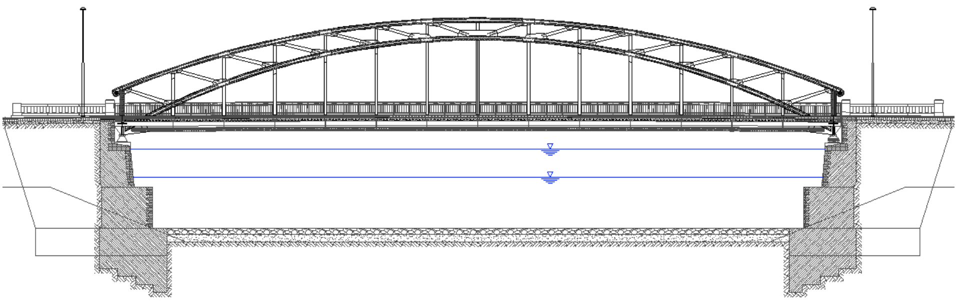

Fig. 1. *Diagram of the bridge.*

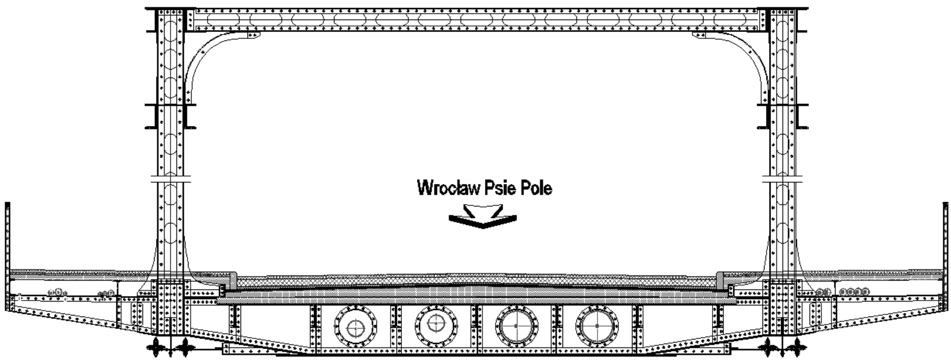

Fig. 2. *Cross-section of the bridge.*

Repair work on the bridge lasting from late autumn 2014, completed recently (01.10.2015). Facility under its former name Nakonz-Brucke built the company Beuchelt of the Green Mountains, under the regulation of Wroclaw Floodway after the floods of July 1903. During the post-war use of object several times repaired, performing, among others: a new reinforced concrete slabs on the sidewalk, a new bituminous surface on the roadway, installation of new expansion joints and performing extreme cross-support.. Superstructure is composed of two truss arches with a brace made entirely as riveted. Main girders are arranged at a spacing 9.50 m. The deck is suspended on the arches by means of rigid hangers. Quite interesting solution is the node connecting the hanger, the crossbeam and tie, in which the tie is suspended the way enabling longitudinal displacement. Crossbeams are spaced 4.225 m, longitudinal beams IN 380 are spaced 1.250 m. In the lower level of crossbeams X-shaped wind brackets made of L80x120x12 mm are placed. The greatest structural damage is extensive corrosion of deck, wind brackets hangers with local cracks at the joints of hangers to crossbeams.

Fig. 3. *A general view of the bridge during repair.*

Fig 4. *The reinforcement of the wall of the abutment.*

The scope of the current renovation is very comprehensive and includes mainly:
- Replacement of the existing slab to new slab by reinforced concrete, connected to longitudinal beams by local shear connection,

- Replacement of all longitudinal beams for new IN 380 mm beams,
- Replacement of wind brackets,
- Replacement of defective rivets on new or screws,
- The strengthening crossbeams,

- Strengthening hanger-crossbeam connections,
- Renewal of the paint,
- Renew the insulation of the gas pipe and water pipe,
- Installing new lighting of the bridge,
- The execution of a new drainage system of the bridge,
- The thorough renovation of access roads and the environment next to the bridge.

3. RECONSTRUCTION OF THE DECK AND CONNECTION TO HANGERS

Scope of design work within the platform included the replacement of the existing longitudinal beams(for new beams from S355), compensation discovered at the stage of design and supervision of wastage of steel structure and construction of a new reinforced concrete slab. During the construction phase, after the demolition of the existing bridge plates, found extensive losses corrosive material (with a total perforation section included), occurring particularly intensely in the areas of contact a reinforced concrete slabs with steel structure elements. Additional new steel plates have been used to strengthen many existing elements of steel structure . The reinforcing elements are combined with the existing structure using fitted bolts or hot riveting. To ensure the tightness at the connections existing elements (degraded due to corrosion) with new plates, they have been mounted on a layer of the wet epoxy resin. Longitudinal cantilevers have been totally reviewed next to abutments. New stringers have been set on the cantilevers in a way that ensures full freedom of longitudinal movements, which represented a return to the original static scheme (within the previous repair work on the bridge combined these elements with each other).

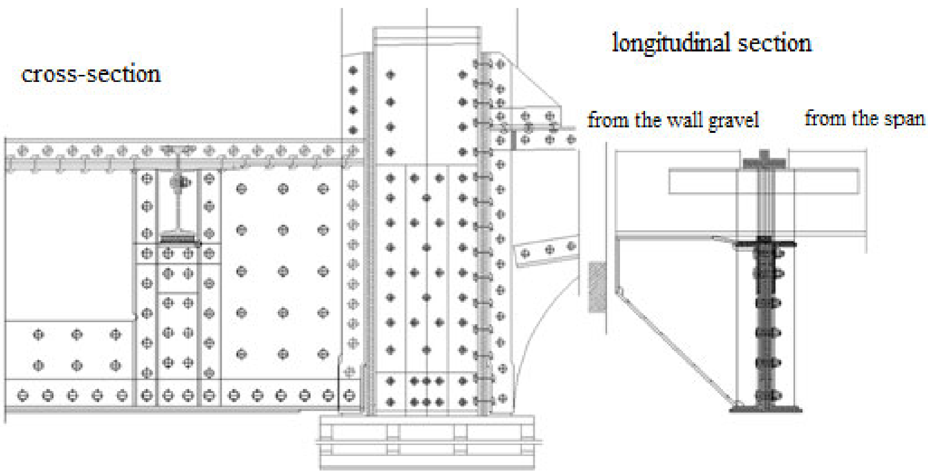

Fig. 5. *Support crossbeam after strengthening and cantilever in line of longitudinal beam next to abutment.*

a)

b)

Fig. 6. *a) Corrosion of supporting column and b) crack of hanger next to the crossbeam.*

Fig. 7. *Corrosion of longitudinal beam next to first crossbeam.*

Fig. 8. *Corrosion of crossbeam and hanger at midspan.*

Fig. 9. *The way of repair of hanger-cross beam connection and strengthening of the web of crossbeam.*

4. ANALYSIS STATIC - STRENGTH UPLOADS

In order to determine the internal forces in the structural elements FEM model have been constructed. On the basis of the internal forces stresses have been calculated in the structure. Key assumptions used in the calculations are:

- stringers are simply supported beams between the cross members,
- bow tie rod is continuously suspended in each node of the crossbeam. Crossbeam at midspan is fixed to bow tie. All elements connected over bearing are fixed together.
- in the FEM model we assumed that hangers can get a little rotation next to the lower chord of arch, but there is kept convergence of movements,
- hinge connection of lower wind bracents are used.

The overall visualization of the calculation model shown in Fig. 10 a i b.

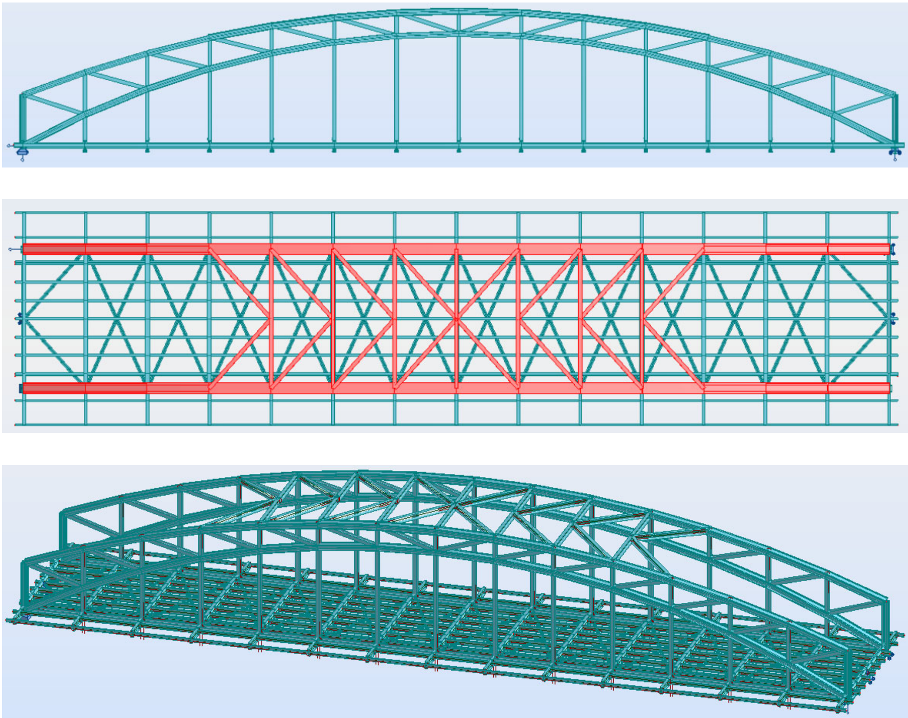

Fig. 10 . *Visualization of the FEM model.*

The correctness of the assumptions made at the stage of the calculation, and the effectiveness of completed repair work was confirmed by the results of the test load of the bridge (Fig. 11).

Fig. 11. *Jagiellonian Old South bridge during the load test (10/01/2015).*

5. CONCLUSION

Completed renovation and repair of the bridge elements has improved service conditions of the bridge - it helped to increase the safety of vehicles, pedestrians and cyclists. Advanced corrosion, mainly on deck elements, could be verified only at the stage of performing of repair works. It confirmed the rightness of the decision on the need of repair facility and the fact that it should be done many years earlier. Very extensive range of repair work (as evidenced by a tonnage built of new elements), as well implementation of new reinforced concrete slab helped to prolong the continued operation of the bridge.

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