BRIDGE OVER THE VISTULA RIVER AT TOWN OF PULAWY

J. Bąk, K. Grej

Pomost Warszawa, Bridge Design Department, Warszawa, POLAND.

e-mails: j.bak@pomost.com.pl, k.grej@pomost.com,.pl

SUMMARY

The bridge over the Vistula River is situated on National Road No. 12 which forms the northern bypass of the town of Pulawy. According to the recommendations specified by the Environmental Protection Institute the bridge was designed "from embankment to embankment". The width of the area between the embankments at the crossing is approximately 1000 m.

The bridge has been designed as a continuous fourteen-span structure with a total length equal 1012.0 m. In terms of its static solution the superstructure is a continuous beam in which the main stream span and the spans adjacent thereto are strengthened with an arch construction. In the main stream span the superstructure girder is suspended to a parabolic arch with theoretical length of 212.0 m.

Keywords: *Arch bridges, steel structure, composite structure, mid-height roadway level, assembling methods.*

1. INTRODUCTION

Pulawy town is located in the eastern part of Poland by the biggest Polish river - Vistula. Until the moment the new bridge was built, traffic was carried out on the bridge which was built in 1932.

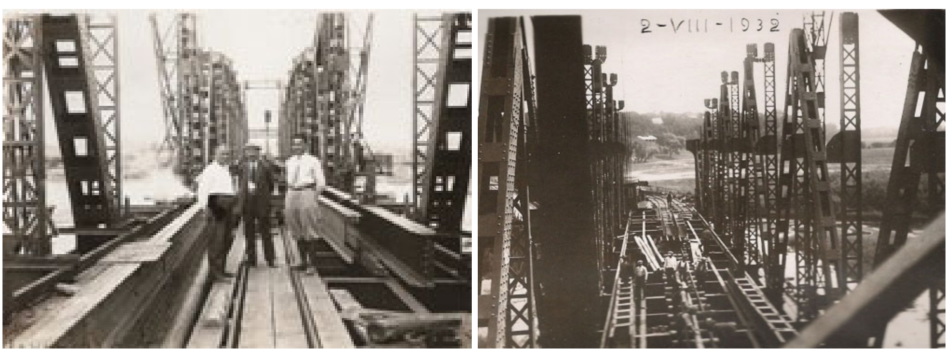

Fig. 1. *Construction site, 1932.*

The bridge was overloaded, too narrow, not adjusted to the contemporary traffic conditions what is shown on fig. 2. The road on the bridge led to the town centre not only the local traffic but also the transit one what was the reason of communication difficulties and essential pollution with exhaust fumes.

Fig. 2. *The old bridge traffic jam.*

Around 2000 a decision was made to build a new bridge and demarcation of the bypass of Pulawy town. The bypass was demarcated in the distance of ca. 2.6 km to the north from the present bridge. A dual carriageway was designed with the width of 2 x 3.5 = 7.0 m with the emergency lanes of 2.5 m. Apart from the bridge over the Vistula river there were other 14 bridge objects built on the bypass.

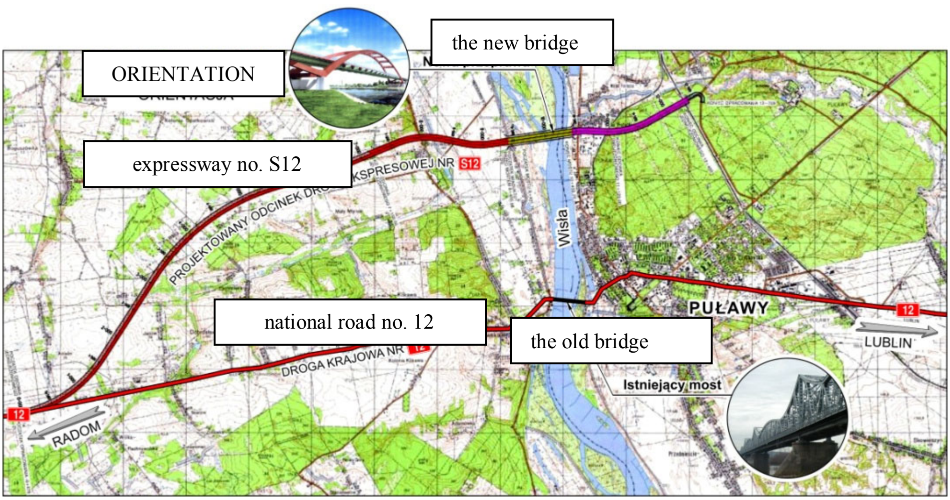

Fig. 3. *The old bridge and the new one.*

2. BRIDGE DESCRIPTION

The bridge is 1012.0 m long and 22.3 m wide. The static scheme is the fourteen-span beam in the main span strengthened with the steel arch (the bridge deck is suspended to the arch structure). The main span length equals 212 metres.

On the flood area a superstructure in the cross-section is composed of two pairs of plate girder beams of constant height amounting to 3.0 m connected with transverse beams located every 4.0 m. On the steel structure a reinforced concrete slab is based which cooperates both with the main girders and with the transverse beams.

The bridge structure is based on supports via bearings.

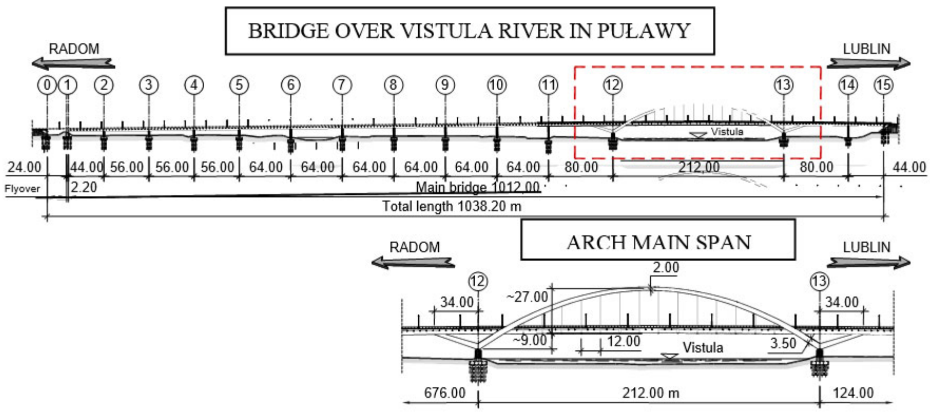

Fig. 4. A side view.

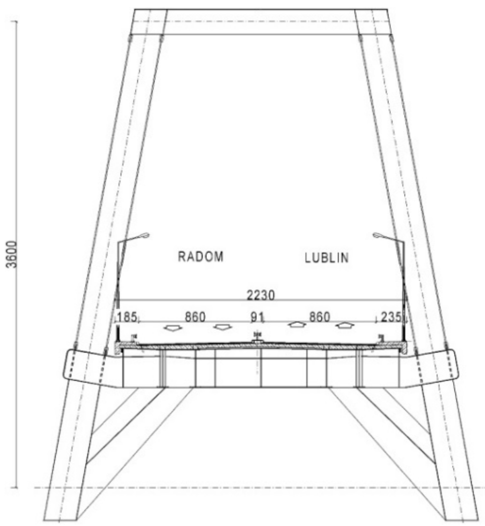

Fig. 5. Cross-section in the main span.

The superstructure of the main river span is composed of two arches. The arches are inclined at the angle of 10 degrees from the vertical position and located outside the bridge deck. In the bridge skewbacks the arches change into oblique structural elements - struts directed towards the approach spans and connected with a deck. The arch height measured from the level of bearings amounts to 36.0 m, 9.0 m of which is located below the deck level while the remaining 27.0 above. In the top part of the arches, braces were applied in the form of six box beams. In the lower part, the main arches are connected with transverse beams in the deck level and above the supports in the bearings level. The structural section of the arch, top stiffeners and main transverse beams in the bridge deck level are designed as closed box sections.

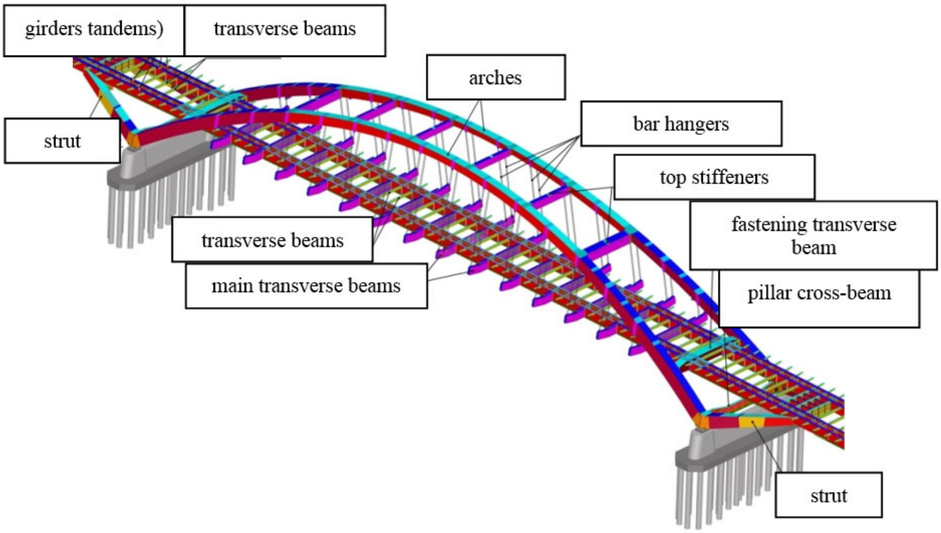

Fig. 6. *Bridge calculation scheme.*

The bridge deck of the main span also plays the role of the arch tie-beam. The platform in the main span, just as in the approach spans, is composed of two pairs of girders (tandems). The girders are connected with transverse beams in the module span of 4.0 m. Two types of transverse beams were planned. The main beams are located every 12.0 m. Bar hangers are fixed to the beams cantilevers. Between them in the span of 4.0 m, the slab supporting cross-beams are found.

The arch has a box cross-section, the webs are inclined from the vertical level at the angle of 10 degrees what corresponds to the arch inclination as a whole. The figure below shows the arch cross-section. The height of the arch section in the top segment is 2.0 m, at the base is 3.5 m. The box width is constant and amounts to 2.5 m.

The deck suspension to the arches is realized by means of 14 pairs of bar hangers. Each hanger is composed of 4 bars with the diameter of 81 mm. The bars are connected both with the cross-beams at the bottom and with the arch structure at the top by means of pins and a fork-like connection.

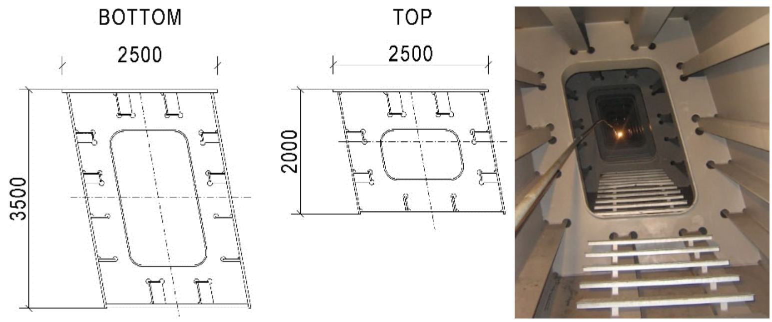

***Fig.** 7. Arch cross-section. Photo showing the arch interior.*

***Fig. 8.** Hangers anchoring.*

3. CONSTRUCTION TECHNOLOGY

3.1. Division into assembly sections

The left-bank approach part of the bridge is a section with the length of ca. 638.0 m starting from the support no. 1 and ending behind the support no. 11. The right-bank approach part of the bridge is ca. 86 m long and starts before the support no. 14 and ends at the abutment no. 15.

The assembly of the approach parts was realized partially by means of cranes. Some elements were lifted with the use of straight-through presses fixed on the previously assembled by means of the cranes structure elements.

3.2. Deck assembly in the river part

After the assembly of the structure on the main supports (no. 12 and no. 13) in the main river bed assembly supports TM1 and TM2 were made. Then, by means of cranes located on barges, J59 and J64 elements were assembled on which the straight-through presses were fixed with the help of which the subsequent 3 elements supplied on barges were lifted. The weight of the lifted elements amounted to 380 tonnes and 555 tonnes.

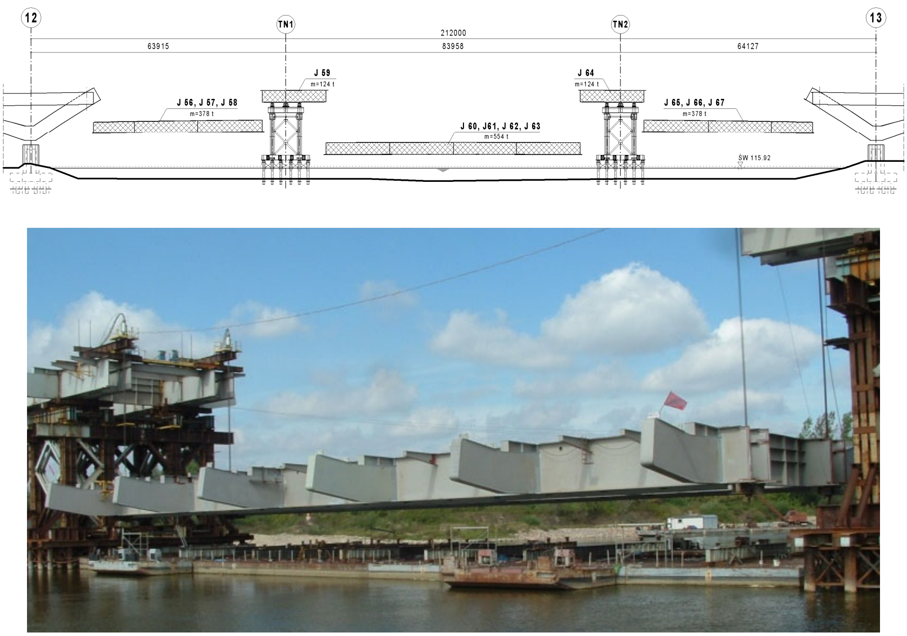

Fig. 9. *Deck assembly in the river part.*

3.3. Arch assembly

The assembly of the main span arch was the most complicated technological operation in the process of the bridge construction. The method involving sliding of the arch structure together with the assembly supports on the previously made deck girders was applied and then the arch elements were lifted and rotated to the target location. The arch structure was divided into 3 elements - 2 symmetrical side elements with the length of ca. 75 m and weight of ca. 700 tonnes and the central element with the length of ca. 36 m and the weight of ca. 260 tonnes. The total weight of the structure introduced on the main span platform with the assembly towers amounted to over 2700 tonnes.

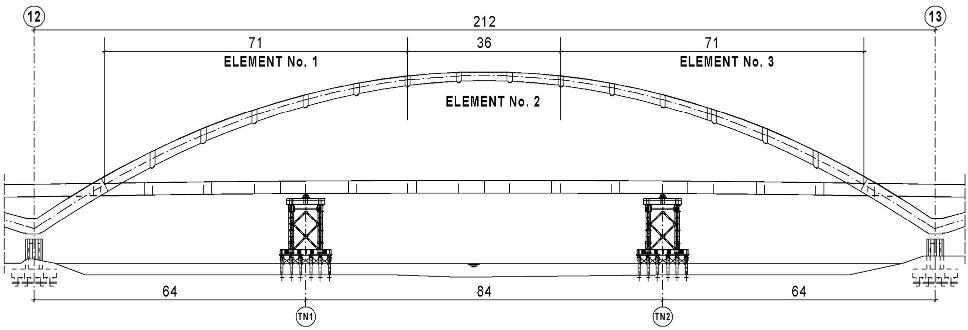

Fig. 10. *Arch division into assembly elements.*

The arch assembly elements were placed on the towers in the assembly site prepared on the embankment behind the right-bank abutment.

Fig. 11. *The first arch element on the assembly site on the embankment behind the abutment.*

The length of the element no. 1 was ca. 75.0 m. The element was supported on 2 tower supports (WP1 and WP2) used for transportation and lifting and on WO5 support, on which a joint was formed which allowed for rotation. The structure was transported in almost horizontal position. The total weight of the left arch assembly element was ca. 700 tonnes and the weight of technological supports and transportation carts amounted to ca. 500 tonnes.

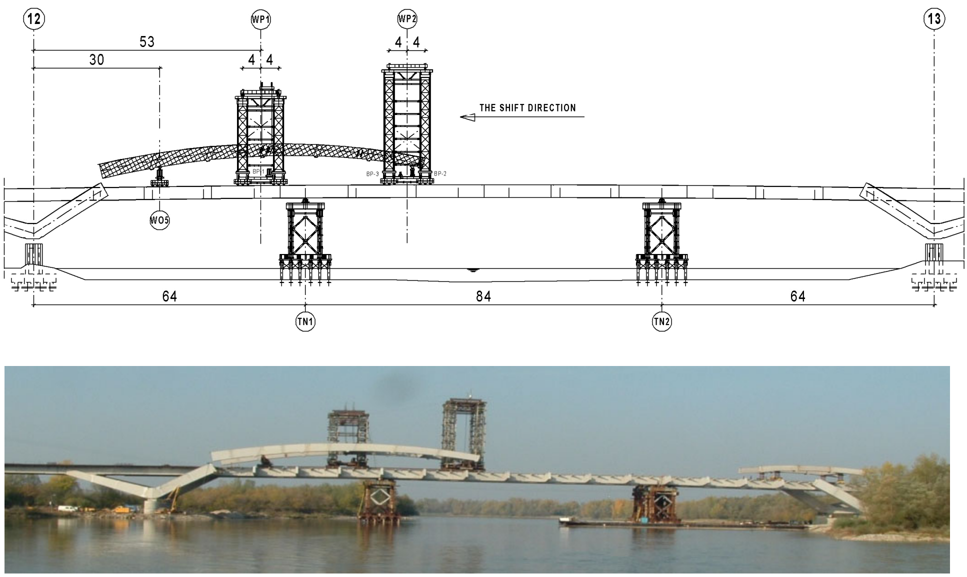

Fig. 12. *Sliding of the first arch element.*

After sliding the element no. 1 the element no. 2, the middle one, with the weight of ca. 260 tonnes was moved. It was supported on 2 transportation supports. The supports were used only for the purposes of the element transportation. After shifting the element to the middle of the main span it remained there until the moment the assembly element no. 3 was fixed.

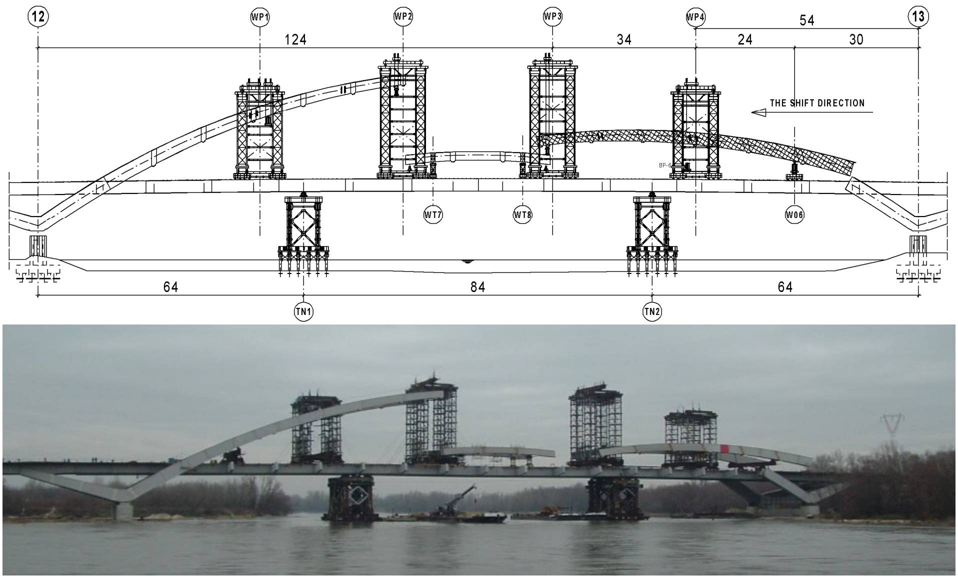

Fig. 13. *All the arch elements ready for lifting and rotating.*

Fig. 14. *Lifting of the last arch element.*

After the assembly of all the arch elements, bar hangers were assembled and their initial tensioning was performed. Then the assembly supports were dismantled, the reinforced concrete slab was casted and equipment elements were fixed. The end stage of the bridge assembly was final tensioning of the hangers.

Fig. 15. The bridge in Pulawy.

4. CONCLUSIONS

The construction of Pulawy bypass with the bridge over the Vistula river was completed in 2008. At that time the main span was the longest arch span in Poland and one of the longest in Europe. The bridge arch in Pulawy is not directly connected with the tie-beam, the connection is realized by means of cross-beams and struts. It influences on the bridge visual valour but also is a challenge for designers and contractors. And they both faced the challenge with success.

A monitoring system has been installed on the bridge which allows for observing its operation on an ongoing basis. The observations may be carried out remotely with the use of applicable software both by the object administrator and the designer. The bridge has been used for eight years without any problems and the results of the monitoring process confirm the legitimacy of the project assumptions and prove the professionalism of the companies which participated in its realization.

In the recent years one can notice the development of the bridge arch structures of essential span in Poland. In the authors' opinion because of the arch architectonic valour the tendency shall be accepted with satisfaction.