FELIKS PANCER - POLISH ENGINEER, VISIONARY AND HIS WORK (1798-1851)

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SUMMARY

Feliks Pancer (1798-1851) was a prominent Polish engineer, famous for his innovative and courageous projects. Three of his works provided him a worldwide recognition in the society of engineers. Two of this projects were executed: the bridge over the Wieprz River near Kośmin built in 1841 and the viaduct along the road leading toward the Vistula River in Warsaw, which was later named after its designer. This paper brings those famous projects of Feliks Pancer closer.

Keywords: *Bridges, history, arch bridges, masonry bridges, iron bridges, timber bridges.*

1. LIFE AND PROFESSIONAL CAREER [1, 2]

Felix Pancer (Fig. 1) was born on May 27, 1798 in Bodzechów, near Sandomierz (Poland). He got basic education in Wąchock and Cracow. In 1815-1818 he was studying mathematical and technical sciences at the Faculty of Philosophy of the Jagiellonian University. In 1818 he joined the corps of the Military Engineers of the Polish Kingdom, which was under Russian domination. For the army, he built wooden bridges for the Modlin Fortress and over the Augustów Canal. He also built a swing bridge in Zamość, for which he was advanced to the rank of lieutenant. His talent and engineering knowledge were highly appreciated by the superiors in the army. In 1827 he was invoked as the professor of architecture at the School of Military Application in Warsaw. He conducted his lectures on architecture of structures, building materials, road construction and theory of arches. Pancer left the army in September 1830. He participated in the November Uprising. In 1932 he was employed as an engineer in the Government Commission of Internal Affairs, Spiritual and Public Education, in the same time carrying out teaching activities in the field of engineering. In 1838 he developed a water pipelines project for the city of Warsaw, which was the basis for its further development. Warsaw water supply network construction began in 1851. Also in 1838 he created the design of the bridge over the Wieprz River near Kośmin, which was built in 1841. In 1844-1846 he carried out the project of the access road from the center of Warsaw to the pontoon bridge crossing the Vistula River. Feliks Pancer died in Warsaw, in 1851.

Fig. 1. *Feliks Pancer [4].*

2. ACHIEVEMENTS IN THE FIELD OF BRIDGE ENGINEERING

2.1. The bridge over the Wieprz River near Kośmin

In the first half of the 19th century one of the most interesting arch wooden bridges in the world was erected. It was a road bridge along the Warsaw-Lublin route crossing the Wieprz River near Kośmin [2]. The single-span arch wooden structure was founded on stone masonry abutments (Fig. 2).

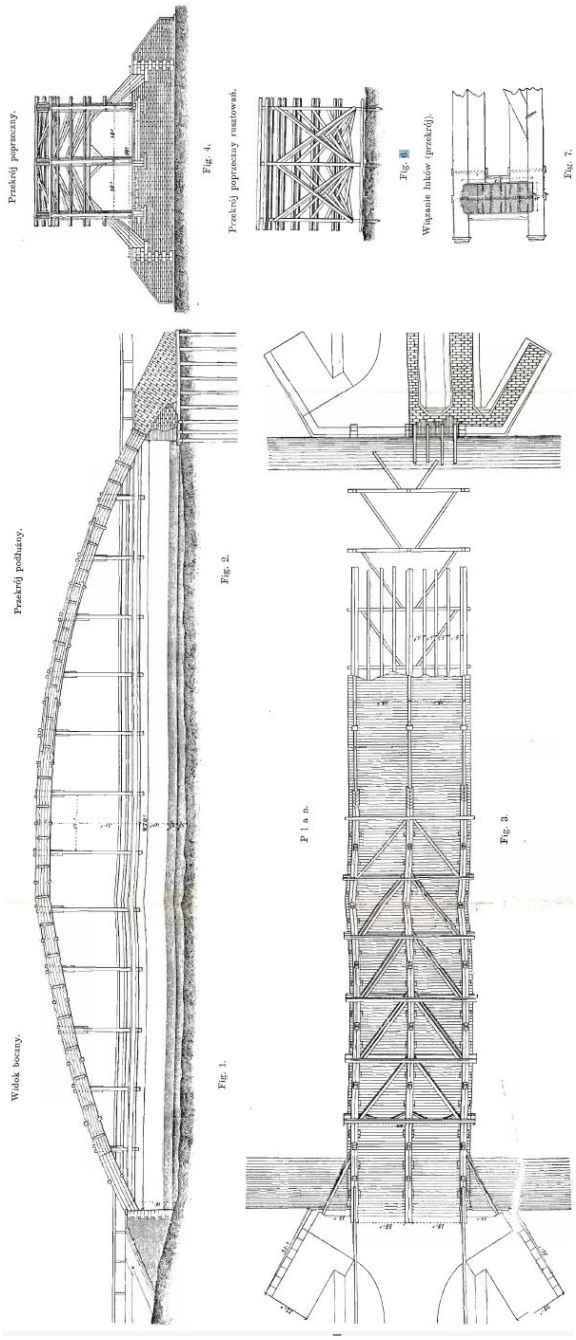

Fig. 2. *The bridge over the Wieprz River near Kośmin (1841-1856) [2].*

The arches were based on iron pillow blocks embedded in the abutments. In the cross-section there were three arch girders with a spacing of 5.18 m, which resulted in two separate roadway lanes. Length of the span was 76.80 m and the arch height was 8.93 m. Each arch was composed of ten beams bent to a predetermined curvature. The beams were arranged in two rows (5 × 2), 1.42 m high and 0.58 m wide. Each of the arches consisted of 74 elements with an average length of about 10.00 m and a square cross-section of 0.28 × 0.28 m. The beams were bent on a special frame by stressing the tie rods and heating the elements over the fire. Unfortunately there is no information on the used wood species. The arches were assembled on a lightweight scaffolding. Individual elements of the arch beams were pressed against each other using metal frames. After tensioning, the beams were joined with iron fasteners. After forming the arch segment, the elements were connected by bolts in vertical and transversal direction. Furthermore, to ensure the interaction between the individual elements (beams) of the arch, there were drilled holes into which oak dowels were hammered. A wooden deck was suspended to the arches using steel rods. The arch girders were connected by wooden wind bracing. Similar lateral bracing was under the deck. The abutments were made of bricks and stone blocks and were founded on wooden piles. Engineer Julian Surzycki (1820-1882) was the construction manager. Franciszek Miaskowski, the owner of Kośmin, financed the bridge so it was a private-public investment, as we would say today.

According to Feliks Kucharzewski "*... During crossing even the greatest weights ... any movements are not visible, apart from the simple vibration, which is perceptible only for the bridge user. That kind of vibration is common for wooden bridges . Big storms, to which the bridge has been exposed, did not cause in it a slightest movement*". From the quoted record there follows that the bridge provided high usage comfort.

Unfortunately, this great engineering masterpiece, described in the technical literature of that period, endured only 15 years due to the insufficient protection of the wood against the weather conditions.

2.2. Pancer's Viaduct along the slip road toward the Vistula River in Warsaw

It was the first half of the 19th century in Warsaw. The route from the city center toward the Vistula River and the existing floating bridge was leading along narrow, steep streets. Improving the connection of the city with the bridge was essential. In the 40s of the 19th century this task was entrusted by the municipal authorities to Feliks Pancer.

The designed slip road to the Vistula River was 675.0 m long and 20.5 m wide. It was located on the embankment, part of which was a masonry brick viaduct with a length of 127.0 m. The structure of the viaduct consisted of seven barrel vaults with clear spans of 3 × 14.76 + 14.50 + 14.10 + 12.60 + 9.94 m. The supports were built on shallow foundations, wooden piles and frames. The viaduct was in use until 1944, when it was blown up by Germans during the WWII. Today the tunnel of the East-West Route is located in this place.

2.3. Concept of the iron bridge over the Vistula River

In 1831 Feliks Pancer introduced a conception of an arch iron bridge over the Vistula River in Warsaw, with a span of 576 m and a height of 150 m. Superstructure of this bridge was designed in the form of a spatial arch truss girder. Structural elements were proposed in the form of cast iron box profiles (square tubes). The castings had flange

Fig. 3. *View of the Pancer's Viaduct in Warsaw (photo: J. Biliszczuk's private collection).*

ends, which allowed to connect them with bolts. This solution was proposed for the connections of the main chords, diagonals and bracings. Pancer estimated that it was necessary to use 4540 tons of cast iron, to built this bridge. This gives 492 kg/m^2 which can be considered a realistic value.

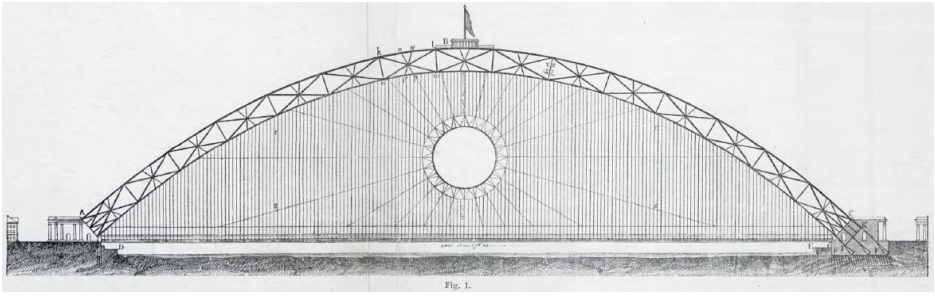

Fig. 4. *The conception of an iron bridge over the Vistula River(1831) [3].*

It was planned to suspend a 16 m wide wooden deck to the arch using five rows of wrought iron rods. Pancer conducted static and strength calculations, taking into account wind loads and temperature changes in addition to the dead loads and the live loads. It

proves his very good recognition of the problem, and it was only 1831. It was a visionary bridge project exceeding the technological possibilities of that age.

3. CONCLUSIONS

Feliks Pancer was an outstanding engineer and visionary of his era. In 1841 he built the largest wooden arch bridge in the world. It is worth to be emphasized that the span length of the arch bridge proposed in 1831 for Warsaw has not been surpassed till now. It will be surpassed only after construction of the Sheikh Rashid Bridge in the United Arab Emirates, with a span of 667.0 m [3].

REFERENCES

[1] BILISZCZUK J., *Mosty łukowe w Polsce. Historia, współczesność, przyszłość.* WSIM, DWE, Wrocław, 2015.

[2] KUCHARZEWSKI F., *Inżynier polski Feliks Pancer i jego prace.* Wyd. E. Wenda i S-ka. Warszawa, 1900.

[3] www.roadtraffic-technology.com/projects/sheikh-rashid-bin

[4] www.wikipedia.org