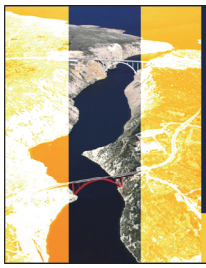

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DESIGN AND CONSTRUCTION

NEW WARSAW BRIDGE OVER THE ODRA RIVER IN WROCŁAW

Jan Biliszczuk[*], Wojciech Barcik[+], Jerzy Onysyk[#], Przemysław Prabucki[“] & Krzysztof Sadowski[&]

[*] Prof., Civ. Eng., Wrocław University of Technology,
Research & Design Office MOSTY-WROCŁAW, Wrocław, Poland
jan.biliszczuk@pwr.wroc.pl

[+] M.Sc., Civ. Eng., Research & Design Office MOSTY-WROCŁAW, Wrocław, Poland
wbarcik@mosty-wroclaw.com.pl

[#] PhD, Civ. Eng., Wrocław University of Technology,
Research & Design Office MOSTY-WROCŁAW, Wrocław, Poland
jerzy.onysyk@pwr.wroc.pl

[“] M.Sc., Civ. Eng., Research & Design Office MOSTY-WROCŁAW, Wrocław, Poland
przemek.prabucki@mosty-wroclaw.com.pl

[&] PhD, Civ. Eng., Wrocław University of Technology
krzysztof.sadowski@pwr.wroc.pl

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Abstract: *The new Warsaw Bridge was built parallel to the existing bridge that has been in use since 1916. It is a road-tram six-span continuous steel beam structure. Its longest span is a Langer arch with a span of 61.9 m. The superstructure consists of two steel boxes braced by crossbeams, composite with a concrete deck slab. The slab was erected using precast panels and prestressed above the supports. Incremental launching method was used for construction of steel part of the superstructure. Due to the location of the bridge in the urban area, particular attention was paid to the architectural details. The bridge was opened to traffic in 2008.*

1 INTRODUCTION

In the place of presented structure wooden bridges were already in use in the 19th century. In 1870 a four-span iron bridge, supported by stone pillars founded on wooden piles was built. This bridge was demolished in 1914-1916 and at the same time a concrete structure that has been used till present day was built. The old Warsaw Bridge consists of eastern and western substructure. The eastern bridge has five concrete arch barrels with spans of 27.80 ÷ 33.50 m and a concrete tied arch with a span of 54.90 m [1].

The need for an alternative exit route to Warsaw forced the decision to rebuild the road system and build new Warsaw Bridges. Its location is slightly shifted upstream, so that the reconstructed old structure can still be used. The works included:

- construction of new bridge, carrying a double-track tramway line, single two-lane carriageway (direction outwards the city) and a route for pedestrians and cyclists;
- renovation of existing concrete bridge, carrying after the reconstruction a single two-lane carriageway (direction towards the city).

The new bridge consists of two structures [2]. The eastern bridge is a six-span steel-concrete composite structure. Main span over the navigation channel is a Langer arch. The superstructure has two box girders, braced by steel crossbeams. Figure 1 shows a side view and top view and Figure 2 a cross-section of the bridge. The western bridge is a single span prestressed concrete frame. Both bridges are founded on drilled piles.

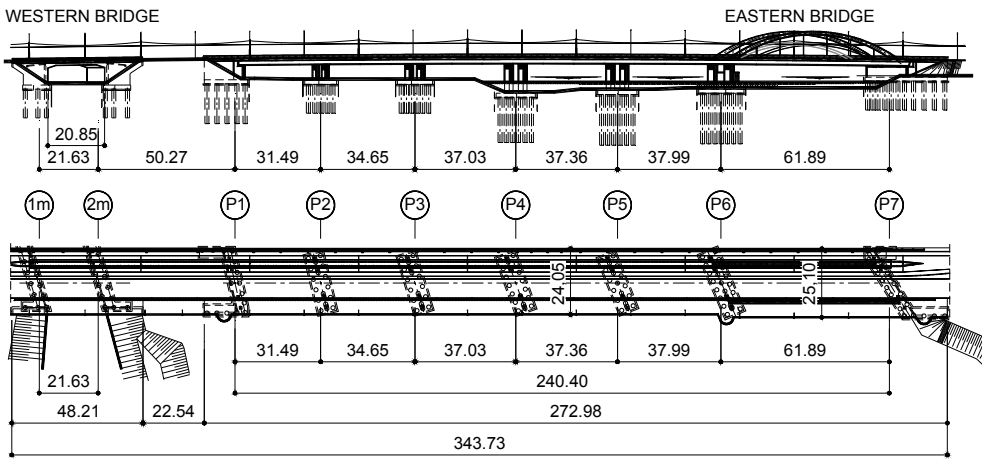

Figure 1: Side view and top view of the new Warsaw Bridge

2 SUPERSTRUCTURE OF THE EASTERN BRIDGE

The eastern bridge is a steel-concrete composite box structure. Static scheme is a continuous six-span beam with side, longest span strengthened by an arch (Langer arch type), as in Figure 1.

Geometric characteristics of the bridge are as follows:

- total length: 240.40 m;
- span lengths: 31.49 + 34.65 + 37.03 + 37.36 + 37.99 + 61.89 m;

- variable skew angle of spans, aligned to the axes of existing supports of the old bridge: $\alpha = 76.98°$ (P1 support) ÷ 57.94° (P7 support);
- depth of the superstructure constant along its length but variable in the cross-section - height of steel structure: 1565 mm, thickness of the deck slab: 260 ÷ 420 mm;
- two double-cell (in the beam spans) or triple-cell (in the arch span) box girders (spacing of 14.50 m) in the cross-section, connected by crossbeams;
- width of the bridge: 24.05 m (beam spans), 25.10 m (arch span);
- height of the arch: 12.50 m;
- hangers made of tendons used in cable-stayed bridges: 19L15 type contained in white HDPE outer sheath pipes.

The new structure carries the following traffic:

- double-track tram line;
- carriageway 2 x 3.50 m = 7.00 m;
- route for pedestrians and cyclists, 4.50 m wide.

The materials used for the construction of the superstructure are given in Table 1.

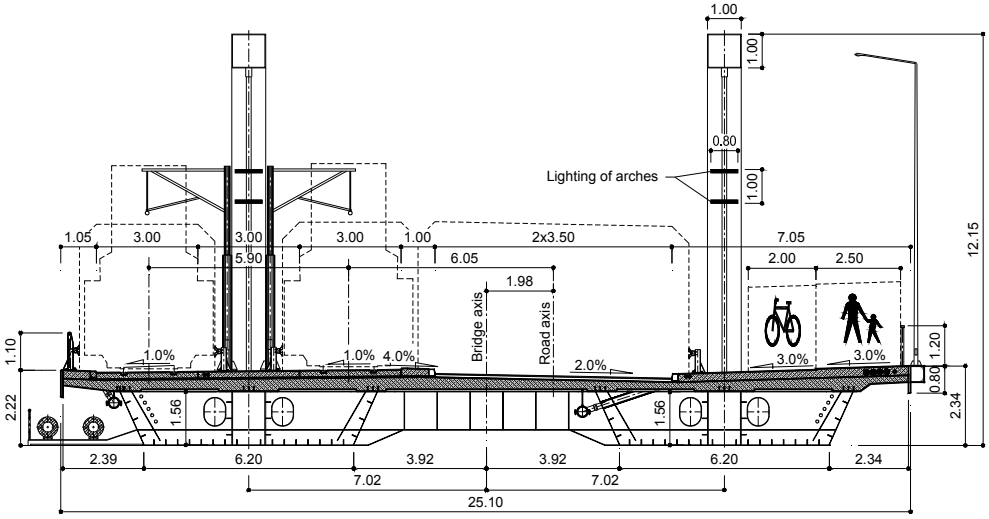

Figure 2: Cross-sections of the eastern Warsaw Bridge in the main span

Material	Unit	Amount
Structural steel, grade 18G2A	t	2066
Reinforcing steel of the deck slab, grade BSt500	t	770
Prestressing steel in the deck slab, unbonded tendons, L15 strands	t	5.7
Steel in hangers, tendons 19L15	t	2.55
Deck slab concrete, class C37/45	m^3	1900

Table 1: List of materials used in the construction of the superstructure

3 ASSEMBLY OF STEEL STRUCTURE

Steel segments of spans were assembled on a special construction site and then incrementally launched into the final position (Figure 3). All assembling joints were welded on site.

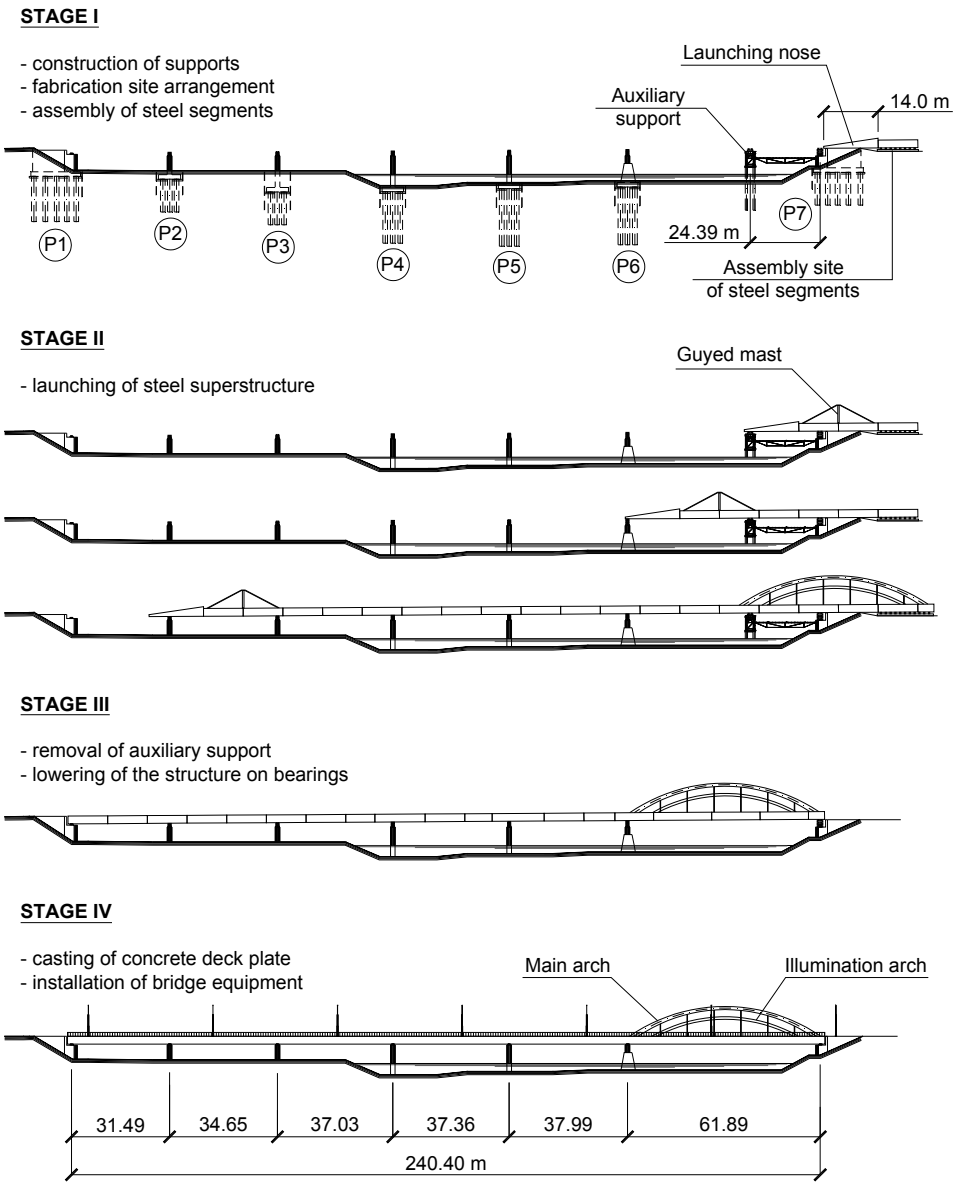

Figure 3: Scheme of steel structure assembly

The launching was performed using:
- steel launching nose, 14.0 m long;
- strengthened front part of the first segment by a steel truss structure;
- a single temporary support located in the navigation channel between supports P6 and P7, the longest span during launching was 38 m;
- temporary sliding bearings with lateral guide.

The assembly was carried out in four main stages (Figure 3):
- in the first step about 70 m long segment was launched using a launching nose;
- in the next steps second segment of the steel structure (60 m long) and subsequently third segment (40 m long) were launched;
- in the last stage the longest span strengthened by the arch was assembled, the launching was performed after the arch and hangers had been completely assembled.

The hangers were tensioned after completion of launching, before removing the temporary support. The last stage of construction was casting the deck plate. Figure 4 shows the process of assembling and launching of the steel superstructure.

Figure 4: Assembly and launching of the eastern bridge superstructure

4 CONSTRUCTION OF CONCRETE DECK SLAB

In order to accelerate the construction of the deck slab it was decided to use a composite deck (precast panels and in-situ cast concrete) instead of a typical monolithic concrete slab cast in-situ. Prefabricated concrete panels with dimensions of 6.00 × 2.05 m, thickness of 9 cm and maximum weight of 3 tons were placed on the steel grid (Figure 5). The panels

have full bottom reinforcement of the deck plate and stirrups ensuring its interaction with the upper layer of cast in-situ concrete.

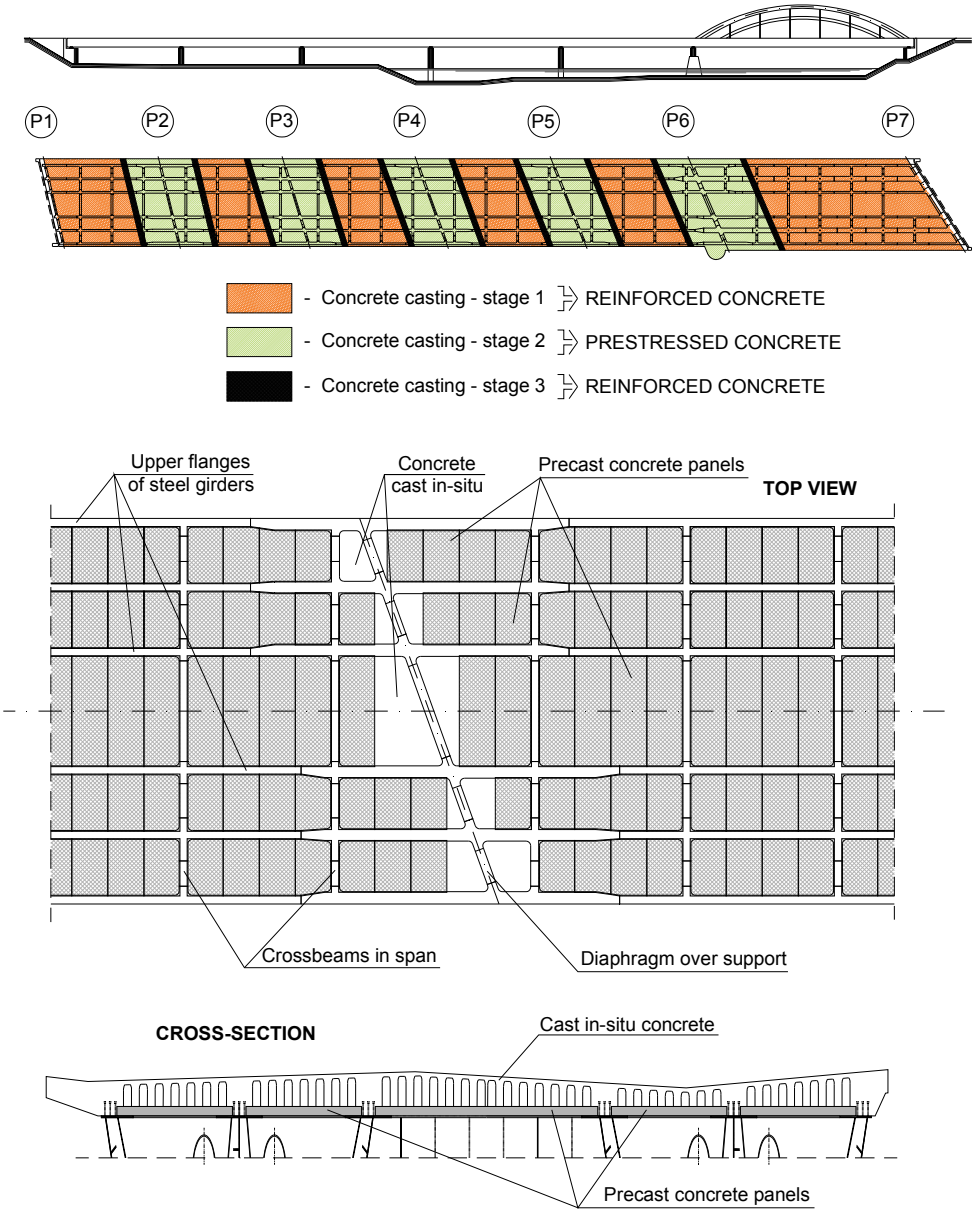

Figure 5: Scheme of deck slab casting and scheme of installation of prefabricated panels on the steel grid

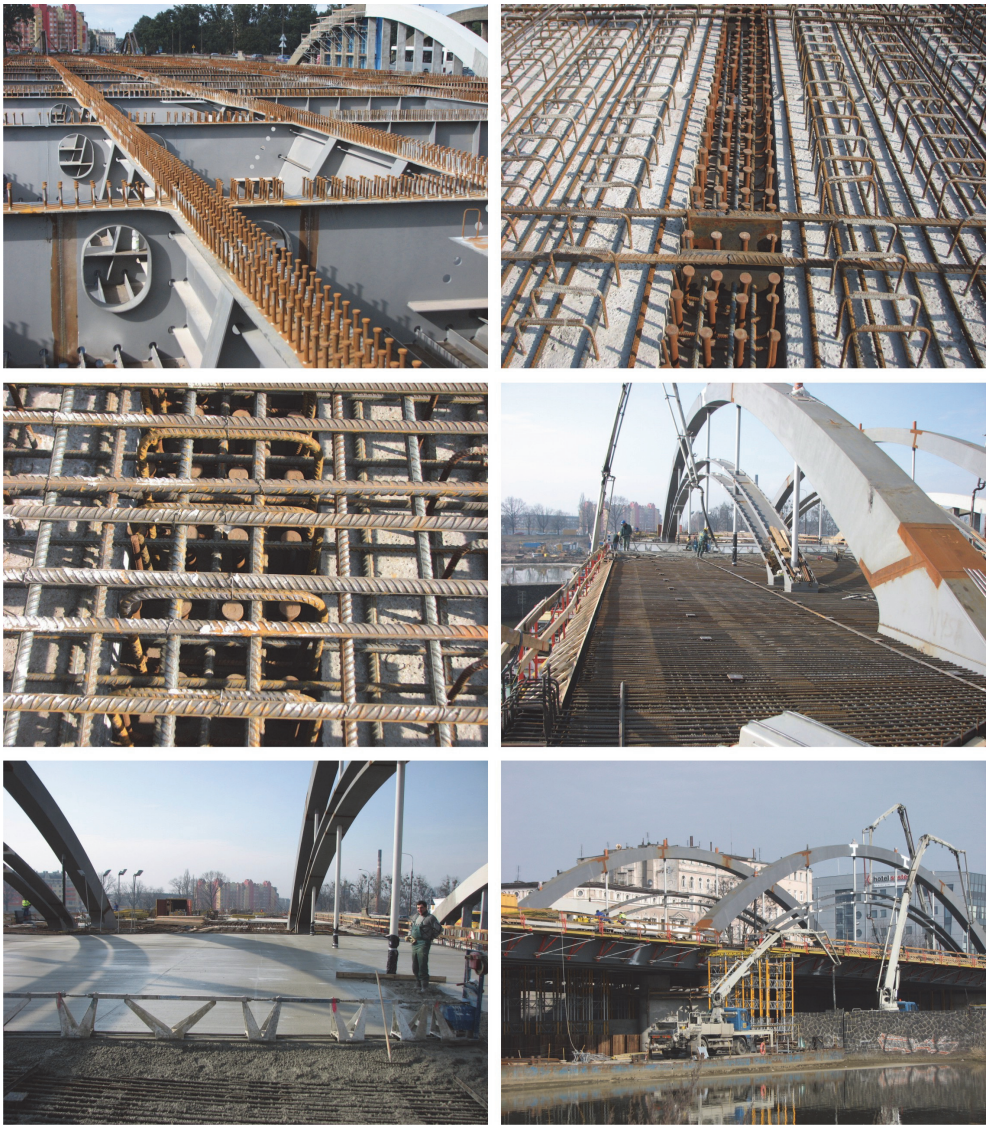

Figure 6: Stages of concrete deck slab construction

After placing the prefabricated panels (between the webs of the girders additional temporary supports were needed) the upper reinforcing bars were added and over the supports unbonded prestressing tendons were installed. L15 type strands were spaced every 0.50 m. Main stages of construction are shown in Figure 6.

Deck plate concrete casting was carried out in stages (Figure 5). In the first stage the zones in the spans of variable lengths were cast. Then concrete was cast in the hogging moment zones (over the supports). Between both areas a 1.5 m wide gap was left uncast to allow

prestressing the plate over the supports. Then the gaps were filled with concrete. Thanks to this procedure a composite superstructure with no cracks in the deck plate was erected.

5 CONCLUSIONS

The new Warsaw Bridge was constructed within two years and after positive results of proof load tests [3] was opened to traffic on 30 August, 2008. Figure 7 shows the interior of completed box girder and the passive anchorage of a hanger. Active anchorages are located in the arch.

Architectural configuration of the bridge and its color scheme is toned down. It seems that it fits well with the urban surrounding. Night-time illumination lights have been installed on the additional non-structural arches, below the main arch structure (Figure 8).

Figure 7: Inside view of the box girder (left) and passive anchorage of the hanger

Figure 8: Overall day and night views of completed bridge

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