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New Conceptual Design for a Cable-Stayed Bridge in Poland

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Summary

The conceptual design of cable stayed bridge design was presented as a contribution to a competition for a new crossing over the Vistula river near Plock in Poland, Europe. The primary idea of the bridge was, that the main, stream span is laid over the Vistula river and it reaches 450 m. length. The bridge has just one pylon, and that is why the span belongs almost entirely to the (as far as the length span concerns) longest ones in the world. The original and unrepeatable view is given to the bridge by the "V" shaped pylon.

1. Brief foredesign

The new bridge crossing, which has been designed across the Vistula river is an element of the Plock town new orbital. The suggested segmentation of the crossing is an outcome of terrain configuration, hydrological and geological conditions analysis and it consists of three general components:

- left bank valley bridge at flooding area
- cable stayed stream section
- right bank valley bridge.

The river is not only a traffic obstacle, but also a technological one. Moreover, the Vistula is an obstacle that brings many troubles connected with supports placed in a midstream setting. Spring drifting of ice as well as frequent floods make Vistula river very difficult area for erecting and maintenance of midstream supports.
Avoiding many hydrological and geotechnical problems connected with that unstable river might be the compensation of slightly higher cost of cable stayed span as compared with traditional one. That is because at present possibilities of new materials and technologies applying, the difficulties of erecting cable-stayed and traditional spans are rather comparable.
Cable stayed bridges are always a sign of strong human activity outstanding in a country

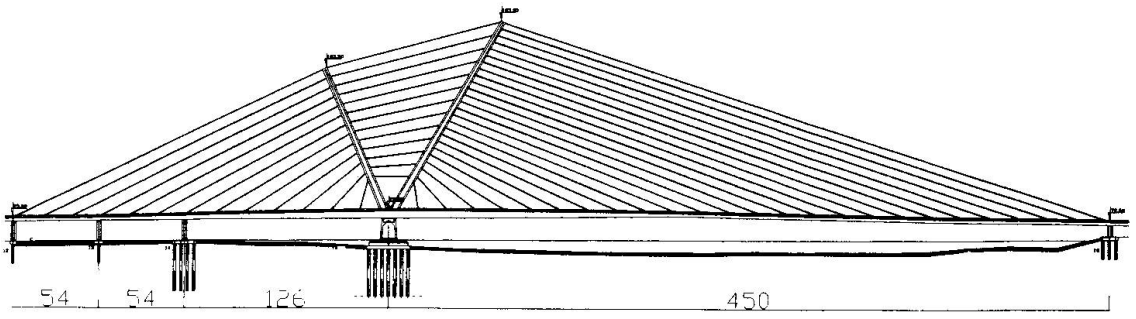

Fig 1. General view of midstream span.

landscape and an evidence of bravery and novelty of engineers' creativity. The bridges of all type, and the cable-stayed ones in particular, play a role of a symbol and of an architectural culture object. As a result of taking all above mentioned facts, the team of our bridge engineers had prepared, as a suggestion to the competition for the new bridge crossing across the Vistula river near Plock, the design of the bridge, which overlays the river with just one cable-stayed span. The aim of the team was to present the structure which differs from the other Vistula river bridges, as a more modern and esthetical appearance one.

2. Bridge structure description

The main part of the bridge (midstream one) consists of four spans 2x54+126+450 m and freely overlaps the river with one, 450 m long span, only. The pylon support is placed at left bank and is being flooded only during the high water levels. On the right side of the pylon, there is a span 450 m long, which overlays the water. The span is constructed as a orthotropic box girder beam made of 18G2A steel, with inconstant height from 5,0 m at pylon section to 2,5 m at the end of the span. On the left side of the pylon there are inundate cable stayed spans, which are concrete (B45) box girder structures. The pylon, placed centrally (in lateral crossing) is designed in a shape of two inclined steel (box section) poles. The split as well as the inclination of the pylon let to minimise its height, preserving big angle of shroud inclination, so the relevant big vertical forces acting on the bridge deck were obtained. Two arms of the pylon are fixed together with the additional ropes of similar to the shrouds structure, to balance the weight of the steel and concrete bridge spans. The concrete cable-stayed spans are placed on three supports (at flooding area) which are used as a shrouds anchorage in addition. Load-carrying structure is stayed with shrouds anchored in pylon and in the cantilevers placed at both sides of spans. This solution was accepted due to the torsional rigidity and as well as, to side wind acting. All shrouds are made of 75 H 15 ropes produced by PPC Freyssinet Company.
Every support was designed as a concrete one, made of B-30 concrete and founded on high diameter boring piles. Two different kinds of them were worked out. Due to big load of pylon support, which carries serious horizontal and vertical forces, and in addition great bending moment, it was founded on 180-cm diameter, 30-m long piles. In non-cohesive soils, which thickness of strata is about 5,0 m here, the piles bore-holes are made under the cover of steel tube, sunk in a clay roof with vibration casinghead. Further on drilling is executed with no cover tube, and the bore-hole is flooded with water, or, in case of water-bearing interbedding at high piezzometric pressure, with bentonite slurry. To increase the load capacity of about 20% - according to existing research- after embedding pile in concrete, the cement injection under the foot and at side surface of pile is performed. The remaining supports are designed as drilled in withdrawn steel 150-cm diameter tube holder with no cement injection.

3. Conclusion.

The analysis performed during the designing process proved that:

- the enlargement of span length causes elimination of midstream supports, which is connected with serious economical savings,
- the heavy concrete span structure placed at one side of pylon causes positive counterweight to the other much longer steel one,
- the "V" shape pylon is an original, not practised in bridge engineering yet, and it allows to reach bigger angles between shrouds and bridge deck and in addition shows an interesting architectural accent.