Cable-stayed bridge over the Labe at Nymburk – Hybrid structure tailored for simple construction

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ABSTRACT: The cable-stayed bridges are competitive for the spans over 100 m to other bridge technologies due to small depth of superstructure and diversity, which enable their individual forming and matching to the given natural or urban environment. The cable-stayed bridge over the Labe River at Nymburk is the first bridge in the Czech Republic of extradosed type with low slender pylons and two lateral suspension planes of stays. The main span of 132 m has 52 m long composite part in the middle, which was floated on barges and then lifted into final position. The technology of construction was very straightforward, however from the beginning a great attention was given to appearance and harmony between the bridge and its location.

1 DESCRIPTION OF THE MAIN BRIDGE SUPERSTRUCTURE

The main bridge superstructure consists of a span over the Labe River and two adjacent spans that are directly connected to the approach bridges. The lengths of these spans are 41 m + 132 m + 41 m. The internal part of the main span, a section of length 52 m, is a composite steel-concrete structure built-in to the ends of the concrete structure. The main span is supported at the end of the concrete section by 3 parallel stays anchored on the pylons. Total length of the bridge is 530 m.

The cross section is of a symmetrical double-girder shape with variable depth and width. The superstructure depth is mostly of 2.3 m. The bridge deck has massive cross beams, which help to distribute the loading from the longitudinal girders and pylons to the bridge bearings. Where the stays are anchored to the bridge superstructure, anchor cross beams are designed. The bridge deck itself is made of C35/45-3a concrete. At both ends of the concrete structure steel embedded members are placed which enables the steel part of the composite section to be welded to the main span. The bridge superstructure is longitudinally prestressed using bonded prestressing tendons DSI 19 × 15.7 mm dia. strands – 1570/1770 MPa. The anchoring cross beams are highly strained at their anchor points and they are also prestressed.

Pairs of separate pylons, 15.8 m high, are erected above main piers. The pylons have a rectangular cross section, 1.1 × 2.0 m, with vertical grooves over their height. The pylons are heavily reinforced with two rows of 40 mm dia. reinforcing bars. To the upper part of the pylons, steel chambers are fixed for the anchoring of the cable stays. These elements are hollow steel boxes, with six thick steel tubes welded into the front faces through which the stays are passed and then anchored. Dampers to minimise the vibration of the stays are placed within the tube sections.

For the stays, the DSI DynaGrip system is used. The anchors are of the DynaGrip C55 type. The anchors are provided with 48 stands of 15.7 mm dia. – St 1670/1860. The stays are jacked and adjusted at their bottom ends.

The middle section of the main span was designed as a composite steel-concrete structure. The steel structure of the dropped in span, with a length of 52 m, is composed of two main steel box girders that are tied by steel I section cross beams at 3.0 m centres. Coupling

Figure 1. Arrangement of the pylon and stays.
of the steel structure to the reinforced concrete slab, 245 thick, is provided by steel studs 19/125 welded on to the upper flange.

2 ERECTION OF THE BRIDGE

Alternative tender proposal was successfully submitted by the Contractor and his Designer and therefore preparation of the Detail Design drawings was only slightly ahead of the construction works on the site. The works on the pile foundations commenced at the end of 2004. Due to the high level of the groundwater, which was dependent on the water level in the Labe, the majority of the foundation pits had to be supported with sheet pile walls and the ingressed water pumped out all the times.

The construction of the superstructure of the approach bridges, as well as the concrete part of the main bridge, was carried out on a supporting structure – falsework. Each part of main span superstructure was cast as one concrete unit with a quantity of 1360 m³ of concrete poured. Following this the concrete shaft of the pylons was erected in two stages. Then the steel heads for anchoring the stay cables were fixed onto the pylons. Once the lateral surfaces of the steel heads were concreted with self-compacting concrete, the cable-stays were installed and activated.

The main girders and cross beams of the steel structure were fabricated, in sections, at the workshop in MCE Slaný and transported to the river port in Mělník where both main girders, including the cross beams were assembled and delivered to the site by boat. Each of the girders was then lifted directly from the boat and placed into the bridge structure by means of a system of prestressing strands and lifting devices anchored to the ends of the concrete sections. After that, the first adjustment of the cable stays was performed, eliminating a deformation from the dead load of the inserted steel structure. After welding the steel girders to the steel elements anchored to the ends of the concrete sections, the temporary fixation of the bearings was released and all the cross beam construction joints were welded.

The bridge deck was cast on a conventional scaffolding system. The scaffolding was assembled and dismantled from a suspended portable working platform. This platform was also used for the application of the top corrosion protection layer to the steel structure. Once the required concrete strength was achieved, the final adjustment of the cable stays was carried out.

3 CONCLUSION

The newly designed bridge over the Labe river has become, because of its location and technical parameters, one of the most outstanding bridge structures in the Czech Republic. The bridge designers’ ambition was, by introducing and using a number of original structural elements and technologies, to contribute to the further use of modern light cable-stayed structures in the given local context. The bridge including the first section of the by-pass was opened to traffic in May 2007. The main parties involved in the Project are as follows:

- Client: Roads and Motorways Directorate of the Czech Republic.
- Designer: Pontex Consulting Engineers Ltd.
- Main Contractor: Joint Venture SMP CZ, a.s. + Metrostav, a.s., D.4 + PSVS, a.s.