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Steel Bridges on the Peripheral Motorway, Ankara, Turkey

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Summary

Erection aspects of steel orthotropic bridges recently constructed on the Peripheral Motorway around the Ankara city in Turkey are discussed in this paper. Two bridges having a main span of 147m have been erected by method of launching from two banks with further locking in the center span. And one bridge having a main span of 105m has been launched from one side using a nose. These three bridges have been built using the established in Russia technologies for steel superstructures assembly and incremental launching. A thorough assessment and review of each erection stage in the design ensured a reliable structural behaviour of permanent and temporary structures.

Keywords: bridges; erection; launching; steel; superstructure; locking; design.

1. Introduction

A final selection of the route alignment of the Ankara Peripheral Motorway necessitated three large bridges crossing Cubuk and Bayindir water reservoirs and Karatas valley. The Cubuk, Bayindir and Karatas bridges have total lengths of about 300, 400 and 600 m respectively. The steel box girders with orthotropic deck were adopted for all three bridges.

A special feature of the construction of these bridges is the erection of steel superstructures by method of incremental launching. Peculiarities of steel superstructure erection when launching is proceeded from two sides with a closure joint in the center of the main span and from one side using a nose are further discussed in details.

2. Project Description

The Cubuk bridge is a continuous three-span structure with a span arrangement of 73.0 x 147.0 x 73.0 m. The Bayindir bridge has a continuous five-span system with a span arrangement of 52.5 x 73.5 x 147 x 73.5 x 52.5 m. The Karatas bridge has a six-span continuous superstructure system which is based on 84.0 x (4 x 105) x 84.0 m spans. The bridge cross section accommodates dual carriageway, pedestrian footways and carry service cables.

The design of the superstructure was based on the normal Russian standards using loading as per AASHTO and special highway loading. The substructures were designed to the AASHTO standard. The bridges are located in a seismic zone and have to withstand seismic forces corresponding to a ground acceleration of 0.12g. The seismic design was carried out in accordance with the AASHTO-SDHB recommendations with some modifications for local conditions.

3. Fabrication, Transport and Assembly

Steel structures for Cubuk bridge were fabricated in Voronezh, Russian Federation. Fabrication for Bayindir and Karatas bridges were carried out in Dnepropetrovsk, Ukraine. The fabricated in the shops elements were first transported by railway, then on a ship over the Black Sea and at the end by road to reach their final destination at bridge sites.

For the Cubuk and Bayindir bridges assembly of half the length of each superstructure was carried out behind the north and south abutments. For the Karatas bridge the assembly of the superstructure was implemented behind one abutment only. After assembling the segments sequentially, the superstructure is launched out into the spans.

4. Erection by Method of Launching

4.1 Erection Design

To ensure a reliable structural behaviour of permanent and temporary structures, various problem areas were studied. These were examination the behaviour of girders during the process of launching, estimation stress levels in the structural components of steel superstructures and some others.

4.2 Launching from Two Banks

For the Cubuk and Bayindir bridges launching have to be implemented from two banks of the reservoirs. Then the launched superstructure halves have to be jointed in the middle of 147 m central span. This is a rather delicate operation which requires relevant accuracy and experience. The difference of temperature within the steel contour was an important consideration for locking operations. The superstructure "lock" joint was welded in accordance with the required sequence. After completion of welding works the kentledge was removed from the superstructure ends. The superstructure ends were simultaneously raised by jacks at the abutments while the lifting forces were controlled by manometers.

Compared to the Cubuk bridge, the locking of five-span superstructure of the Bayindir bridge required two temporary joints at the superstructure. When two superstructure halves were launched to their final position in the central 147 m span, the temporary joints were disconnected to allow superstructure position adjustment. Most of the operations were similar to those of the Cubuk bridge.

4.3 Launching from One Side

The Karatas bridge launching was implemented from one side. To reduce stresses in the launched superstructure, a launching nose was used for the superstructure. In addition deck orthotropic plates between the boxes and at side cantilevers were not installed at the "head" of the launched superstructure.

The strength analysis outlined some critical points at top of the deck in the last 84 m span. Therefore to reduce built-in stresses a special erection sequence for the top deck orthotropic plates was required.

5. Conclusion Remark

The construction of the Cubuk bridge was started in the mid of 1993 and completed in 1996. The construction of the other two bridges commenced a little later. The Bayindir and Karatas bridges were opened to traffic along with the relevant parts of the motorway in 1997 and 1998 respectively. All three bridges provide a landmark structures on the route which forms a part of the transportation system development in Turkey.