Transformation of unused road infrastructure to combined road-railway infrastructure

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Summary

The article discusses the transformation of a highway median to railway infrastructure. The emphasis is on the retreiving of an existing, unused viaduct, part of an interchange on one of the busiest highways in Belgium. Other modifications of structures are shortly discussed.

Keywords: post-tensioning; slab track; mixed road-railway traffic; upgrade structure

1. Introduction

In order to improve the accessibility of Brussels airport, Infrabel, the Belgian Railway Infrastructure Manager, started the Diabolo-project. The Diabolo-project consists of improving train access to Brussels airport in order to link it to the north (towards Antwerp/Amsterdam). Part of this Diabolo-project is located on the unused median of the highway E19 between Brussels and Antwerp.

The main structure to convert on this median was the E19/R0 interchange structure, R0 being the circular highway around Brussels. The Diabolo-project transformed the structure into combined road-railway infrastructure.

2. Reinforcement of the E19/R0 interchange structure

The state of the existing infrastructure was sufficient to defend retrieving and reinforcement rather than a new structure. Retrieving also meant that demolishing the old and constructing a new bridge across the busiest highway in Belgium could be avoided.

The existing infrastructure consists of three consecutive, continuous prestressed concrete bridges. All bridges have two adjacent bridge decks, one deck for every driving direction.

2.1 Substructure

Fig. 1: Construction of new abutments

The modifications of the substructure were different for the piles, the abutments of the two outer bridges and the abutments of the central bridge.

The piles were retrieved, and reinforced. Additional jet grout piles reinforced the foundations, and both the foundation slab and the shaft were enlarged. These modifications fostered the placement of jacks to lift the deck up from its bearings. This made the replacement of the bearings possible.

All abutments were completely renewed. The abutments of the outer bridges remained high, the

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new abutments of the central bridge were low. All abutments used jet grout piles as foundation piles, and provided temporary structures to place the deck on jacks. Like for the piles, this way the bearings could be replaced and the existing abutments demolished.

2.2 Superstructure

The existing bridge decks were prestressed, concrete box girders. The post-tensioning cables were internally bonded cables of the type 12T15, all located in the longitudinal beams.

In the longitudinal direction, the decks were reinforced by adding new post-tensioning cables. Depending on the tensile stress to compensate, a minimum of 3 and a maximum of 8 cables 27T15 were provided. Of course these cables had to be external cables. Given the fact that the bridge decks are box girder bridges, the cables could be introduced in the voids between two longitudinal beams.

The combination of the additional prestress component and the existing reinforcement present in the longitudinal beams resulted in sufficient shear strength for the deck. No other interventions were required regarding the shear strength.

In transversal direction, a lack of bending moment capacity, due to a lack of reinforcement, was solved through providing externally bonded reinforcement. A carbon fibre reinforced polymer was used.

3. Installation of railway track on the E19/R0 interchange structure

Two more problems were encountered regarding the installation of railway track on the renewed structure.

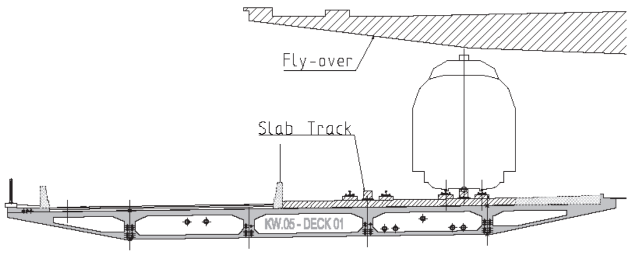

Fig. 2: Cross section of the deck

Firstly, the upper slab of the box girder bridge had insufficient strength to distribute the train loads and ballast weight to the longitudinal and cross beams. An additional slab with thickness 30 cm above the upper plate was provided to transfer the train loads to the subjacent structure.

Secondly, the clearance height posed a problem because of the presence of two fly-overs. The shortage in clearance height was solved by a combination of two measures: the provision of slab track, and the lowering of the entire deck over 13 cm.
A cross section of the deck, with the slab track and the fly-over on it, is given in figure 2.

4. Other transformations in the Diabolo project

The Diabolo-project's length is approximately 20 km located on the median of the E19. Next to the interchange structure E19/R0, another structure to be modified was the crossing of the E19 with the Watertorenlaan. This structure consisted of four adjacent concrete structures with an inverted U-shape. A first calculation of the existing structures showed that the structures were totally insufficient to carry the train loads. Because of the demand to limit the inconvenience for the road traffic, a reinforcement of these structures was chosen over a new structure. The two inner structures were transformed into tubes, by adding post-tensioning cables in the upper slab, thickening the walls and the provision of new jet grout piles and a foundation slab.

5. Finish

Begin 2012, the complete Diabolo-project was successfully finished with the certification of the railway line, including the interchange structure. Since June 2012, the railway line is operational and eases access to Brussels airport coming from the north.