Constantine Viaduct, Algeria

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Summary

The Constantine Viaduct is a major road and bridge project in Constantine, Algeria. The project will improve the infrastructure significantly when completed in 2014. During the design, special attention has been given to road traffic solutions, pedestrian access and aesthetical aspects due to the urban location. The main design challenges associated with placing a major road and bridge in the middle of an old city with many restrictions have been defining the alignment, complex geometry of bridge structures and need for extraordinaire geotechnical structures. The new viaduct bridge will be a significant cable-stayed bridge on the African continent. It will stand out as a very elegant cable-stayed bridge with its slender appearance, clear lines and prominent location next to the other famous and beautiful bridges in Constantine.

Keywords: Constantine viaduct; infrastructure; road; cable-stayed bridge; concrete box girder, post-tensioning; composite girder; retaining walls.

1. Introduction

Constantine Viaduct, also known as Viaduc Transrhumel, is a road and bridge project in Constantine, the third largest city in Algeria. In 2008 it was decided to upgrade the infrastructure in the city by building a new viaduct in order to relieve the other very congested bridges. The winning design/build project comprised a modern and elegant cable-stayed bridge, the next natural step for the city with many historic arch and suspension bridges, known as the "city of bridges". The project comprises a 750m long cable-stayed bridge across the valley, two access bridges at the south abutment, 4 access ramps at the north abutment, 2 underpasses, an overpass and several retaining walls along the 10km of new and refurbished roads. The alignment is constrained due to the hilly terrain and existing infrastructures and buildings resulting in complicated geometry and high degree of heterogeneity. This, combined with the numerous access roads, has resulted in 4km of retaining walls of very variable types. An inspection and maintenance manual has been prepared as an integrated part of the design process with the aim of minimising the future operational costs.

2. Project definition

The purpose of the Constantine Viaduct is to provide a direct link between the city centre and the northern part of the city for both local traffic and through traffic. This means that it has been important to connect the new road to the existing roads within the project area and at the same time ensure free traffic flow for through traffic. The south and north interchanges at the ends of the viaduct are therefore grade separated. The existing steep narrow streets at the south end have been turned into one-way roads to provide two lane entry and exit to the viaduct. The north interchange includes 4 ramps connecting the busy Batna road with the main road. The piers for 2 of the north ramps are partly located on the steep slope and the other two ramps cross a railway meaning that construction using scaffolding is difficult. The ramps have therefore been designed with composite girders where the open steel boxes are erected span by span and provide support for constructing the concrete deck slab. The main road is a 4 lane highway from the viaduct abutment to the north

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end of the project at roundabout D. The road is placed in a corridor between dense residential/ commercial areas and a military area. The terrain in the project corridor is hilly with various local roads, utilities and scattered buildings. The cable-stayed bridge is described in the next chapter.

3. Cable-stayed bridge

The main bridge is a cable-stayed bridge with a main span of 259m, central stay cables and central pylons. The girder is a 28m wide concrete box girder. The continuous girder is monolithically connected to the two pylons and supported on bearings at the piers. The girder is located up to 80m above ground. *Fig.1* shows the elevation of the main bridge.

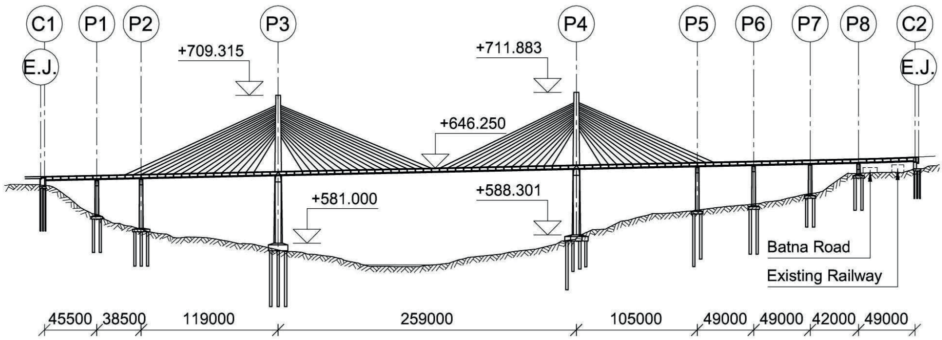

Fig.1: General arrangement of Main Bridge, elevation

All piers and pylons are founded on pile foundations. The piles are 2m diameter bored concrete piles. The geotechnical conditions at the site are very variable and comprise limestone, marlstone, marl, conglomerate and fill. This has resulted in extensive soil investigations with more than 175 boreholes. A detailed geophysical survey was carried out to locate old inactive fault lines at the project site. Discovery of karstic cavities at the P4 foundation resulted in the development of a foundation solution including micro piles and grouting. The two pylons P3 and P4 are central one leg concrete pylons approximately 130m high. The girder is monolithically connected to the pylons. The two pylons act together with the deck as a frame for longitudinal forces. Restraint forces from time dependent effects and temperature loads are moderate due the flexibility of the tall pylons. The structural behaviour of the bridge during an earthquake is to transfer all longitudinal forces at the pylons only. To minimize the width of the deck, the upper part of the pylon has been made slender and the lower part with corbels embracing the deck which has resulted in a harmonic, beautiful and elegant pylon. The large faces of the pylons are slightly curved, which as a refinement will underline the shape and the passing of the light during the day.

The post-tensioned box girder has a depth of 3,75m and the cantilevers are supported by ribs every 7m. The deck slab has raised footpaths for improved pedestrian comfort. The soffit of the bridge deck will be very visible, as people move around below the bridge. Therefore a lot of effort has been put into making the soffit light and slender and given it a structurally appropriate rib structure that follows the shape, thus creating an aesthetically clear, yet interesting, solution that is not visually aggressive. The grade separated traffic at both ends of the main bridge required to provide an optimal traffic solution, resulted in ramps entering onto the main bridge and hence a need for varying width of the deck. Further, the deck is curved in plan at both ends to align with access roads. This has resulted in complex concrete geometry and more than 40 different diaphragm types. The deck is supported by central stay cables of the parallel strand system. The pylon and pier shafts are being cast using jump form and 4m lifts. The girder is constructed using scaffolding at the bridge ends and cantilever construction for the remaining parts. Pier tables are constructed at piers P1 to P6 and in total 6 formwork travellers are used. Construction is scheduled to be completed in 2014.

4. Acknowledgements

COWI was designer together with architect Dissing+Weitling for the contractor Andrade Gutierrez.