



9th International Conference „Bridges in Danube Basin 2016“, BDB 2016

Design of the new Northern Danube railway bridge in Budapest

Imre Solymossy^a, Peter Gondar^{b*}

^{a,b}*MSc Engineers and Consultants Ltd., Fehér u. 10/a-b, Budapest 1106, Hungary*

Abstract

The article aims to present the challenging design tasks of the reconstructed Northern Danube railway bridge in Budapest. Besides, it gives an overview of the extraordinary construction and replacement process that was carried out within 3 months in 2008. The bridge is located on the Budapest-Esztergom railway line of MÁV (Hungarian National Railways) that carries significant suburban traffic, therefore fast constructability was just as important design issue as load carrying capacity and travel comfort requirements. Meanwhile the design was also determined by cityscape and noise demands. The old temporary structure was removed and replaced by the new continuously supported 674.40 m long steel truss girder bridge in the summer of 2008. A special bearing system enabled the reinforced abutments to carry the increased horizontal loads induced on the continuous girder with the application of hydraulic shock transmission devices, whilst the old piers became released from the majority of horizontal effects. The contractor and the designer were both challenged by the available 3 months long period for the bridge replacement. 500 tons heavy prefabricated units had to be lifted by floating cranes to their position, while no disturbance of the shipping was allowed on the river. As the result of close cooperation between contractors, designers and the involved organizations such a bridge was given back to the traffic 8 years ago that absolutely satisfies all kind of modern demands.

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Peer-review under responsibility of the organizing committee of BDB 2016

Keywords: railway bridge; Danube; continuous truss girder; hydraulic shock transmission device; floating crane

1. Introduction

The history of the Northern Danube railway bridge in Budapest has started 124 years ago. The demand for building a second railway bridge in Budapest next to the Southern connecting bridge first arose in 1892. The Budapest-Esztergom railway line (see Fig. 1.a) was designed for heavy traffic, primarily to carry the trade of stone- and coal-

* Corresponding author. Tel.: +36-1-252-25-59; fax: +36-1-251-33-25.
E-mail address: gondar.peter@mschu.hu; mhc@mschu.hu

mines located along the line. A significant part of the industrial traffic was destined to the left bank of the Danube, therefore a new railway crossing was proven to be essential on the Northern part of the city [1,2]. The original bridge was opened in 1896 connecting Óbuda and Újpest quarters. Due to the geographical conditions another smaller bridge was also built over the bay on the Újpest side together with the structure over the main river branch (see Fig. 1.b).

Because of the increasing load carrying capacity requirements and unfortunate historical events, the original structure has gone through several strengthening modifications and reconstructions since the opening. The importance of the river crossing is confirmed by the fact that it has always been in operation up to this day apart from a 10 years break, although the railway line mainly carries suburban passenger traffic nowadays instead of heavy cargo. The history of the bridge bears several curiosities for the engineers of the 21st century, since the evolvement of the superstructure has always reflected the design standard specifications, material scientific and theoretical knowledge and the available construction resources of their time. This is absolutely valid for the new railway bridge as well, which was opened in 2008 and satisfies all kind of modern demands.

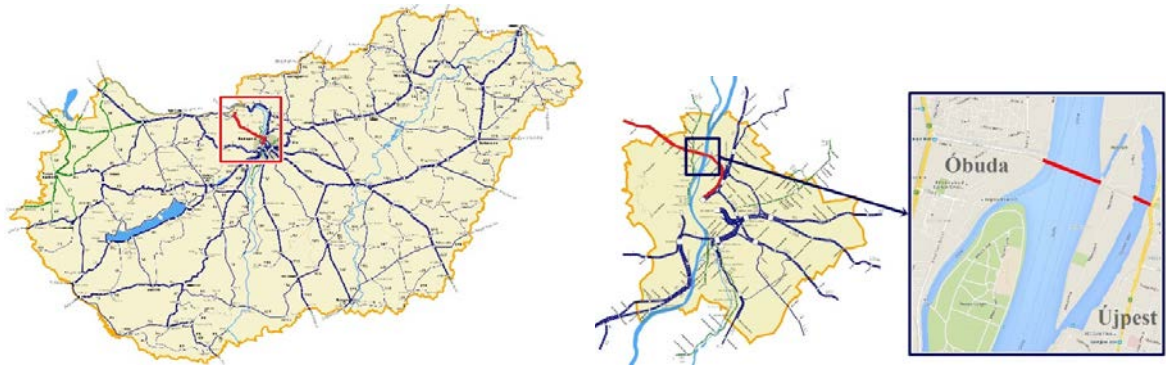


Fig. 1. (a) Budapest-Esztergom railway line; (b) Location of the bridge in Budapest

2. Historical overview of the river crossing

2.1. Original bridge

The Italian Societa Nazionale delle Ufficine di Savigliane company was commissioned by the also Italian first owner of Budapest-Esztergom railway line with the design and construction of the bridge in 1892. The piers were built by using pneumatic caissons. Their foundation depth was chosen 18 m below the zero water level. It is interesting that these substructures have been supporting the bridge ever since only with few minor strengthening works. The superstructure consisted of seven identical Pratt truss girders made of wrought iron with simply supported spans of 92.0 m. The girders were assembled on falseworks. The bridges on the main river branch and over the Újpest-bay were opened on November 3, 1896 [1,2].

Due to the change in design standards and the increase of train loads, the bridge needed gradual improvements. At first an additional middle chord was constructed between the top and bottom chords in order to decrease the buckling length of the columns. In 1911 supplementary diagonals were added into the midspan of the simply supported girders. The train loads had further increased therefore in 1932 secondary diagonal elements were built in (see Fig. 2.a). In addition, new crossbeams were connected to the new columns thus decreasing the spans of the overloaded longitudinal girders. Unfortunately, the destruction of World War II reached the bridge as well when the Óbuda side span got hit by an air raid in September, 1944. In December, five out of the six remaining spans got blown up by the retreating German troops. Later in 1945 the Soviet army built a pontoon bridge at the location of the destroyed crossing [1,2].

2.2. Semi-permanent bridge

The reconstruction awaited for 10 years, because the rebuilding of other Danube bridges in Budapest took priority. Two conceptual designs were carried out but these could not materialize due to lack of iron after the war. The

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