3 in 1 reconstruction of monument Margaret Danube-bridge in Budapest, Hungary

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Summary

Located in the centre of the world heritage site of Budapest, monument Margaret Danube-bridge was built in 1876 and now reached the age of 137 years. The bridge with 6 spans is a series of hinged single supported steel arches with six main girders and a total length of 642 m. During design of the reconstruction three different aspects had to be taken into consideration simultaneously e.g. the structural construction, the traffic development and the monument reconstruction (3 in 1) each with its structural consequences.

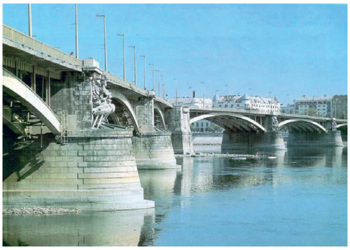

Fig 1. Before

Keywords: monumental bridge, arch steel bridge, structural refurbishment, traffic development, widening of deck, orthotropic deck, optimal solution, traffic under construction.

Fig 2. After

1. Introduction

Margaret bridge designed by the Frenchman Gouin and built in 1876 was the second permanent Danube bridge in the area of today's Budapest. Its refurbishment has become pressing due to its technical state. However, the refurbishment has significantly exceeded the extent of a regular bridge maintenance operation. A bridge is a prominent and significant component in the live tissue of urban traffic, as it meets new demands resulting from the changes required by the age. Therefore, in addition to major refurbishment works to be performed, necessary due to static reasons and important from the aspect of the lifetime of the bridge, simultaneous major traffic development and fulfilment of monumental reconstruction tasks have become also possible which allows accommodation to the requirements of ageing.

2. Design aspects

In its lifetime, the bridge was reconstructed and refurbished several times, following the contemporary changes and the extra demands resulting from the traffic growth. The major aspects of refurbishment were:

- structural aspects: static, design,
- traffic technique, creation of the missing bicycle route,
- even chances in traffic, provision for level accessibility,
- heritage aspects: monument and part of the UNESCO world heritage, i.e. the Danube bank

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section in Budapest,
- other special aspects (tram traffic, public lighting, public utilities etc.)
- operating and maintenance aspects,
- construction organisation aspects,
- cost-efficiency aspects.

When the above aspects were simultaneously taken into consideration, during search for the ideal solution contradictions were often encountered, and therefore, we tried to find an optimum solution meeting also the other criteria.

3.2. Traffic development, provision of even chances

The complete replacement of the deck allowed also traffic developments which improved the non-satisfactory traffic technical parameters of the bridge. Within traffic development, a two way new bicycle rout was established on the northern side, the traffic lanes were widened in the isle curve, the outer road traffic lane was also widened, and the drive-off lanes were extended. To provide chances for the disabled and persons with wheelchairs, a surface zebra-crossing provided with traffic lamps at the isle entry in the middle of the bridge was created for pedestrians with the closure of the subway built in 1937 for public use, and level passing of the pedestrians on the banks was also allowed.

3.3. Monumental reconstruction – Chosen moment

In accordance with the architect L. Wild [1] "The Margaret bridge was built as an architectural composition carefully designed in all its details in 1876 on the basis of plans drawn by the Frenchman Ernest Gouin. After World War II, restoration aimed at operability was performed. By the time of the refurbishment, nothing from the beauty of the bridge was left, only the raw structural frame was visible. The major purpose of the architectural reconstruction of Margaret bridge was to fully regain the beauty of its elements damaged during the war. The aim was to obtain a uniform appearance by harmonising the breast-walls of the bank sections with the world heritage environment by means a squared stone covering, excluding all momentarily fashionable but aging solutions."

3.4. Designed superstructure

3.2.1. Widening of deck – Orthotropic deck

During the refurbishment, in addition to the regular refurbishment works, the existing reinforced concrete slab deck was replaced with a new orthotropic deck having a width of 28.35 m (widening by 2.95 m) and the longitudinal and transversal stiffening trusses of the main girders were partially rebuilt. The columns of the trusses were rebuilt with smaller spacing and stiffened with X-braces in longitudinal direction. To ensure proper spacing of crosses, the six main girders were stiffened with cross braces near the supports. Stiffening of the main girders was unnecessary.

3.2.2. Integration of stiffening X-truss

The existing reinforced concrete slab deck was replaced with an orthrotopic steel deck allowing to rebuild the columns with a smaller spacing and stiffened with X-braces in longitudinal direction. To ensure proper spacing of crosses, the six main girders were stiffened with cross braces near the supports.

3.2.3. Construction - On-site measurement and cutting

During the construction, the on-site cutting and jointing of the steel components connecting to the geometric forms of the existing structure were the largest challenge. The two hinged arch rises/deflects by 20 mm/10°C in the middle of the arch in response to heat effect. This effect had to be taken into consideration in deck cuttings in view of the fact that the individual pieces of the plates were built in at different temperatures and that the effective height of the existing structure was also uncertain.