Expanding and raising of bridges in order to improve navigation conditions

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Summary

The decision to upgrade or refurbish a bridge does not always follow from its technical condition or increased road traffic. Another reason can be the increased clearance requirements below the bridge. That clearance may need to be widened or heightened for the navigation or other infrastructure. This paper presents three upgrading projects that provide a significant increase of bridge navigation clearance – both horizontal and vertical – below the existing bridges.

Keywords: Bridge upgrading, navigation requirements, navigable clearance, bridge span, bridge expansion, bridge raising, jacking, suspension, elevation, sustainability.

1. Introduction

The condition and performances of the Dutch infrastructure are subject to frequent upgrading. This applies to both the land traffic and inland navigation. Sometimes the two come together in the same project. This paper presents three such projects. Their objective was the modification and upgrading of bridges in order to provide more navigable clearance – and at the same better traffic conditions. The discussed three projects are:

- Raising of two bridges, Roosteren and Echt, over the Juliana Canal (Fig. 1);
- Navigable width extension of the Amsterdam Bridge over the Amsterdam – Rhine Canal (Fig. 2).

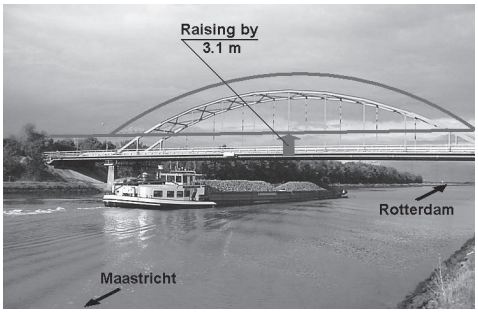

Fig. 1: Echt Bridge over the Juliana Canal

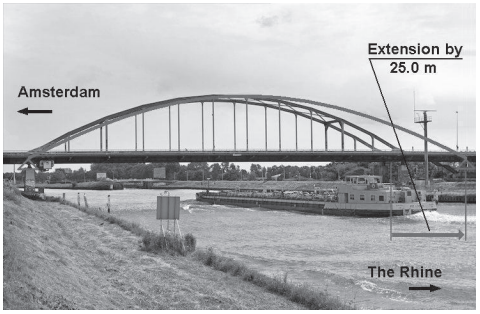

Fig. 2: Amsterdam Bridge, intended extension

The first two bridges, Roosteren and Echt, have already been raised and upgraded. The third project is a design that still waits for realisation. In both cases, extensive structural works were required. Therefore, a thorough investigation on all optional solutions – including the replacement by entirely new bridges – was the first thing to do. This paper presents an approach to and the results of such studies, followed by the description of the selected options. Emphasized are the condition aspects of the existing bridges and the resulting refurbishment works. After all, bridge modifications of this size represent major investments that must guarantee many years of service.

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2. Bridge raising and upgrading

To allow larger and higher vessels pass the Juliana Canal, an important waterway from France and Belgium to the Rotterdam harbour, two bridge crossings Roosteren and in Echt needed to be raised by over 3.0 m. Considering the flat character of our country, this was a significant raise – one of the highest ever done. No wonder that the project required a thorough consideration to the condition of all sub- and superstructures, their behaviour during raising and in raised positions, structure strength etc. Based on that, different optional solutions were considered, including vertical and horizontal replacements that would free the substructure for heightening, new bridge construction etc.

Fig. 3: Raising of the Roosteren Bridge

The most favourable in terms of construction time, economy, navigation and other criteria was the option of vertical jacking-up (Fig. 3). It also appeared to be the most sustainable solution that resulted in a low material and energy input. By preserving the original details – or at least their shaping (Fig. 4, 5) – this option also contributed to the care about heritage. The Roosteren Bridge was raised and refurbished in 2005, Echt Bridge in 2006. They have both performed very well since then. In the paper, the highlights of design, investigations, and execution are discussed.

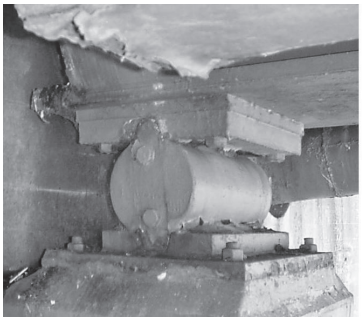


Fig. 4: Echt Bridge, side span bearing – old

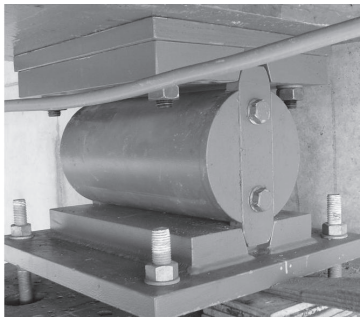
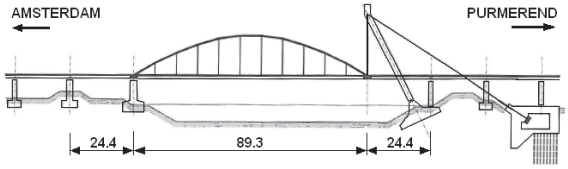


Fig. 5: Echt Bridge, side span bearing – new

3. Extending navigable width

The Amsterdam Bridge, crossing the so-called Zeeburg Passage of the Amsterdam-Rhine Canal, was constructed in 1957 as a steel arch bridge 89.3 m long, with two rigidly coupled side spans, each 24.4 m long. The canal is one of the Netherlands' most intensely navigated waterways, giving a 100 m wide and 6 m deep ship passage. The bridge offers only a 75 m wide ship passage, which presents a navigation bottleneck.



From an assessment of many possible solutions, the suspension of one bridge support to an inclined pylon (Fig. 6) – called "swan's nephew" – appeared to offer the best solution. The results of costs analysis, environmental and other studies are presented in the paper, along with the intended upgrading works.

Fig. 6: Intended navigation width extension of the Amsterdam Bridge