Raising Existing Bridges to a Higher Navigable Clearance

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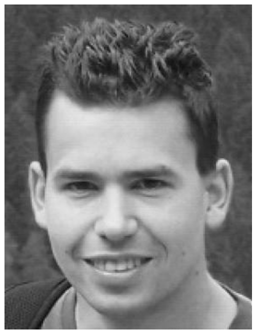

Summary

To improve the navigation on the Juliana Canal, a waterway from the Netherlands to Belgium and France, two bridge crossings had to be raised by over 3.0 m. The raising project required a thorough consideration to the condition of all sub- and superstructures, their behaviour during raising and in raised positions, remaining service life etc. This paper presents the highlights of the project.

Keywords: Inland navigation, navigable clearance, head room, structure raising, bridge raising, jacking, jacking point, jacking system, elevation, pillar elevation.

Choice for adaptation

One of the frequent sustainability issues is a choice between adapting old structures to new (usually higher) demands and replacing them by new structures. The Netherlands develops an intensive inland navigation, which is seen as both economically and ecologically preferable to other modes of transport. In order to increase the navigability of the Juliana Canal, an important inland waterway to Belgium and France, two bridge crossings – Roosteren and Echt – were raised by over 3.0 m. This solution proved to be financially, logistically and environmentally preferable to new construction. A raising project of that size required, however, a thorough investigation of both the condition and the behaviour of all structures involved. Moreover, since both bridges were of an identical, continuous 3-span system, middle arch-span 80.0 m long (Fig. 1), the raising had to be very well synchronized and controlled in order not to generate excessive additional loads.

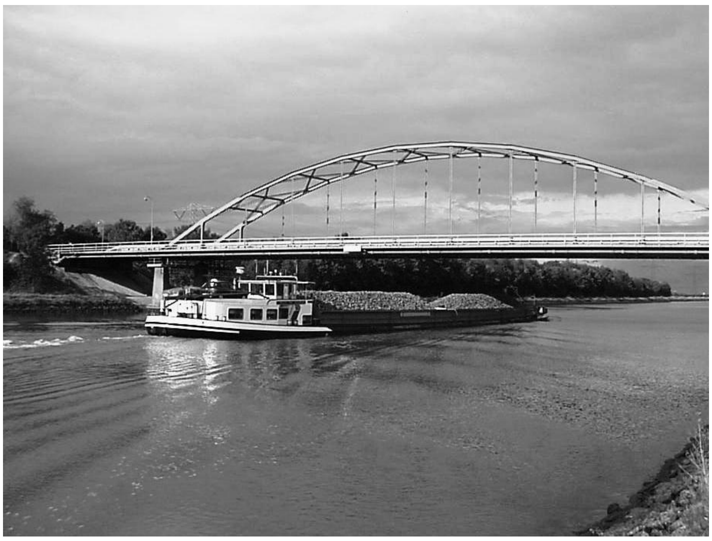

Fig. 1: Bridge over the Juliana Canal in Echt before raising

A number of inspections, analyses, static and dynamic load tests and soil surveys were performed to assess the fitness of the structures for the new service conditions. The most remarkable results are presented in the full paper. Particularly interesting were the deformation shapes of the main bridges and their dynamic behaviour under the test load vehicle moving with various velocities. The investigations allowed pronouncing both bridges sufficiently safe and reusable in the raised position, under some conditions. This, in turn, allowed proceeding with the bridge raising and the levelling of all neighbouring infrastructure. The most spectacular part of the project was, obviously, the raising itself.

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Variable load tests

Although the technical condition of both bridges seemed satisfactory, there was still concern about their remaining service life. Both bridges had been in service for about 45 years at that time. If the remaining service life was not long enough, new construction might still have been a better choice. To eliminate that risk, the bridge that had carried more traffic in the past was subjected to static and dynamic load tests. An investigation of the entire structure was not a workable option.

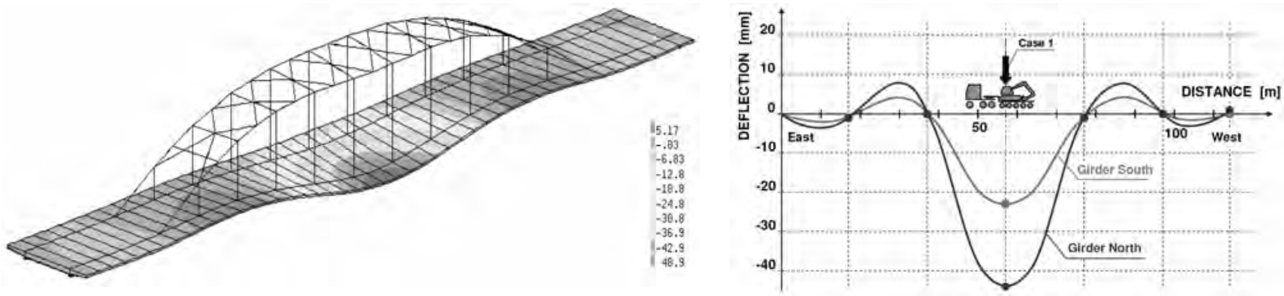
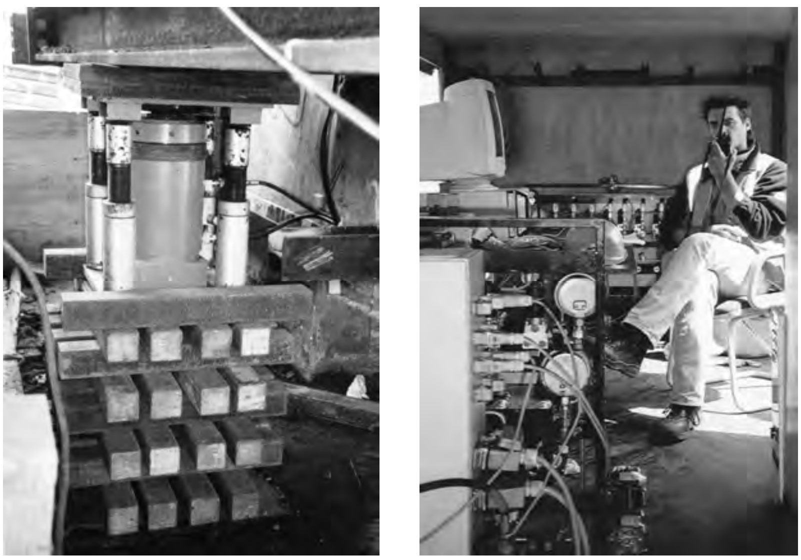


Fig. 2: Bridge analytic (left) and measured (right) deformation from vehicle in middle section

Static load tests (Fig. 2) showed the deformations in the range of 0.7 ÷ 0.8 of the analytical values. This was expected, considering the stiffening effects of actual node dimensions, deck pavement etc., which are commonly neglected in bridge analyses. Dynamic load tests, showed an insignificant deviation from the "static" results for the test vehicle speed of 10 km/h; and a moderate deviation for the speed of 50 km/h. The details are discussed in the full paper.

Raising operation

In the meantime, the bridge pillars and abutments were strengthened. Their elevating was scheduled to take place directly after the superstructure raising in order to limit the use of temporary supports. The load test results removed the last concerns about the superstructure condition. The jacking-up could proceed. Temporary supports and 12 jack-up units were installed under the superstructure (Fig. 3 left). All units were synchronized and computer controlled (Fig. 3 right) in such a way, that the level diversions did not exceed 5 mm during the entire jacking-up of over 3.0 m.



The jacking-up proceeded in steps of 100 mm, every step followed by the filling adjustment. The jack positions allowed for placing the filling bars alternately in both horizontal directions. Precautions were taken to provide sufficient stability under wind loads.

Each bridge was raised about 0.3 m above the desired level, to make space for the substructure levelling. Upon the completion of that, both bridges were lowered back to their final positions.

Fig. 3: Jacking point (left) and control room (right)

Conclusion

The jacking-up of one bridge lasted 2 days. The costs, traffic obstructions and environmental impact were much smaller then in case of a new construction. The applied technology enables the jacking-up of still larger structures, which can be favoured e.g. in costal areas due to the sea level rising.