Recalculation of Hubertus Viaduct in The Hague

Refky GABRA
Civil Engineer
The Hague Engineering Office
The Hague, the Netherlands
refky.gabra@denhaag.nl

Refky Gabra, born 1963, received his civil engineering degree from the University of Delft, the Nederlands. He works for the City Management Department, The Hague Engineering Office, Construction department

Summary

The Hubertus viaduct in The Hague is a continuation of the Hubertus Tunnel. It was built in 1970. The Tunnel has been designed for traffic class 60 (600 kN with a distributed load of 4 kN/m^2), the viaduct for traffic class 30 (300 kN with a distributed load of 2 kN/m^2). Given this difference, the Hubertus Viaduct had to be made suitable for future traffic situation, after opening the tunnel, by recalculation and with possible reinforcement of the structure. The recalculation was done according to the NEN6706 of 2007, the Dutch standard based on the Eurocode.

After recalculation the structure did not meet the requirements for collapse prevention and a number of the cross-sections did not meet the requirements in respect to durability.

Therefore a recalculation using the new guideline NPR BBK - a Dutch standard for Existing Concrete Structures - was done, using a lower load factor. Eventually the structure met with requirements regarding collapse prevention, but not with the durability requirements.

Therefore the dead weight was weighed accurately. The difference between weighing results and theoretical values was acceptably small. Using a lower load factor was there for justified.

Keywords: Computational Methods, Codes and Standards, Quality, Safety, Reliability

1. Introduction

The Hubertus Viaduct, built in 1970, is situated in the Haagsehout/Scheveningen city district as a continuation of the Hubertus Tunnel, which was opened to traffic in the summer of 2008. Both are part of The Hague ring road. The Hubertus Tunnel has been designed for traffic class 60 (600 kN with a distributed load of 4 kN/m^2) in accordance with the VBB 1995, the Dutch standard for Concrete Bridges.

The Hubertus Viaduct was designed at the end of the sixties/ beginning of the seventies for traffic class 30 (300 kN with a distributed load of 2 kN/m^2) in accordance with the then VOSB 1963. Given the difference in traffic classes, the Hubertus Viaduct had to be made suitable for the future traffic situation after the tunnel was opened. This was to be done by means of recalculation in combination with possible reinforcement of the structure of the viaduct.

2. The structure

The viaduct comprises a complex of 5 decks constructed from cast-in-situ and post-tensioned concrete slabs. The longitudinal cross-section of the Plesmanweg and Waalsdorperweg decks comprises two end spans of about 22 m and three middle spans of around 32 m. The Raamweg deck consists of two end spans of about 26 m and four spans of about 30 m. The decks at Madurodam (Prof. Teldersweg) comprise two 17 m end spans, four adjacent 21 m fields and a 26 m middle span. The thickness of the decks is constant and amounts to 1.26 m. A narrowing of 0,305 m over 2,50 m can be found on both sides of the deck. The decks at Madurodam are 0,9 m thick and have up to 0,03 mm narrowing on both sides. The road surface comprises a layer of asphalt with an average thickness of 75 mm.

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The structure includes hollow areas in 3 decks to reduce the proportion of deadweight. A 4,0 m cross girder of solid concrete sheets has been applied at the sites of the support points. The other two decks at Madurodam have been constructed, in view of the short spans, from solid concrete.

3. Recalculation

The structure has been checked using NEN 6706:2007 (replacement for the NEN 6723) for traffic loads on bridges and viaducts. The viaduct did not meet the requirements for collapse prevention. Additionally the construction of a number of the cross-sections did not meet the requirements in respect to durability.

The recalculation has been performed again with the following principles:

- The reference period of 100 years may be reduced to no more than 15 years in accordance with NEN 6706:2007. The traffic load can be reduced by around 6% with a reference period of at least 15 years.
- The traffic number will be around 1000 vehicles per day in 2023, about 270.000 vehicles in 2023. 90% of the truck traffic will use the 1st lane, 10% will use the 2nd lane.
- The actual carriageway layout on the viaduct was used as a basis. The lanes in the direction of the Waalsdorperweg are 3,5 m wide. All the other lanes on the viaducts are 3,0 m wide.

The collapse prevention in respect to the shear stresses has still not been complied with despite the abovementioned “mitigating” circumstances. Moreover the structure of a number of the cross-sections still did not meet the requirements in respect to durability either.

3.1 Recalculation in accordance with the “NPR BBK”

Up until now the approach for calculating the viaduct was to comply with the current applicable standards for new constructions. However a work group has been preparing a new guideline for years, the NPR BBK “Dutch Practice Guideline for the Assessment of Existing Constructions”. The safety assessment of an existing structure differs in this guideline in a number of essential points from that of a new structure. A lower load factor can be assumed for an existing structure with respect to a new structure, by means of measurements and/or weighing.

The structure did eventually comply with the requirements in respect to collapse prevention as a consequence of reducing the load factors, particularly for the deadweight. However the structure still did not meet the durability requirements. The decision was made to determine the deadweight of the concrete decks by accurate weighing.

3.2 Comparison of the weighing results with the theoretical deadweight

The difference between the weighing results and the theoretical values used was found to be acceptably low in the recalculations. The use of a lower load factor is therefore justified. In other words: the viaducts have also proved to be suitable for carrying the traffic that will be going through the tunnel in the coming 15 years.

4. Conclusions and recommendations

All the potential reserves in the structure and the space offered by the regulations have been addressed in the recalculation of the viaduct. It goes without saying that they will restrict the use of the structure in the future and modifications are not permitted. After 15 years, replacement will be considered rather than reinforcement.

The fact that the requirements have not been numerically complied with is by no means a reason to condemn the viaduct in respect to durability. The viaduct must however be structurally inspected and maintenance work should be carried out so that the durability of the structure remains at least at a certain level.