Effects of Light Rail Traffic on a 30 Year Old Cable Stayed Bridge

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Summary

A 30 year old steel cable stayed bridge is being considered for transformation to carry light rail traffic vehicles. The time history of stresses during the crossing of the vehicles demonstrates that the fatigue resistance of the stiffening girders and stay cables does not constitute an issue for this bridge. However, during the process the fact has appeared that the bridge does not behave as a stay cable system, since the pylons are not separated from the stiffening girders and the system is not cable suspended. In addition, the stiffening girders show unbalanced characteristics due to older design assumptions regarding the effective width of the orthotropic plated deck, contributing to the lateral girder resistance. Concerning the plated deck, patch loading by rail vehicles is excessive for the stiffeners and the web plates of the floor beams, the transformation requiring the use of a concrete slab, connected to the steel structure.

Keywords: Cable-stayed bridges, light rail traffic, fatigue, orthotropic plated bridge deck, structural transformation to adapt for new loads.

1. Introduction

During the seventies of last century, society came to believe that public transportation by rail would become useless and disappear in favour of road transport. This has caused the construction of some bridges crossing major obstacles before the connecting roads were actually built. The bridge at Godsheide, crossing the Albert Canal near the town of Hasselt (Belgium) is a striking example, since the connecting motorway was never built.

In recent years, the necessity to reduce energy consumption and care for the environment has re-oriented interest towards public railway transportation. The latter does not necessarily involve classical railway, but may also be light rail systems. In the case of the Godsheide Bridge, the possible installation of a light rail system on the road bridge was to be investigated. This included the verification of stresses both at ultimate limit state and serviceability states for various types of light rail loading, as a quasi-static load, as well as dynamic loading. The verification also included deformations and accelerations of the bridge during the crossing of light rail vehicles and fatigue resistance of all important details, including the stay cables and the steel orthotropic plated deck.

Since the combination of light rail loading with normal road traffic seemed unacceptable, reinforcing of several sections appeared necessary. A procedure for this reinforcement was developed. From the simulations, reported in the following, clearly appears that the basic concept of this bridge does not correspond to a classical cable-stayed bridge. The peculiar concept as well as some misunderstanding about the behaviour of slender steel sections is the main reason for the necessity of reinforcing important parts of the steel lateral girder.

This investigation required the use of detailed drawings from the time of the bridge construction, which fortunately have been found. Concerning the prestress of the stay cables, some information was found in the aforementioned documents. This information has been adopted as true, although some of it may be questioned.

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