VIBRATION CONSIDERATIONS IN THE HILLSBOROUGH RIVER BASCULE BRIDGE REHABILITATION DESIGN

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1. Summary

Hillsborough River Bascule Bridge, located in Tampa, Florida, USA, vibrates significantly under traffic loading and uncomfortable noises have been reported, especially during recent years. The purpose of the study presented here is to investigate the cause of such a significant vibration. First, a brief description of the bridge is given. Then, analytical theory is presented, including the vehicle model, bridge model, road surface model, and numerical methods. A vehicle is simulated as a three dimensional nonlinear model. The bridge is treated as a space structure consisting of three dimensional frame elements. The road profile is modeled as a stationary Gaussian random process that is described by a power spectral density (PSD) function. The bridge free and forced vibration characteristics are investigated with trucks traveling over a rough deck. Then, the stiffness effects of the main girders, bracings, and floor beams are studied. Analytical results show that insufficient stiffness of lateral bracings and floor beams is a main factor causing the severe vibration. Some rehabilitation schemes for mitigating the severe vibration are investigated. The research results are applicable to bascule bridge design and rehabilitation.

Keywords: *Bascule Bridge; vehicle model; bridge model; road surface roughness; vehicle-induced vibration; impact, vibration design.*

2. Introduction

Movable bridges have been an integral part of the U.S. transportation system, their development being in concert with that of the development of the highway and railroad systems. Movable bridges have proved to be an economical solution to the problem of how to carry highway and rail lines across an active waterway. Currently, approximately one thousand movable highway bridges provide critical links in the highway infrastructure system in United States. One of the most important types of movable brides is bascule bridges. Hillsborough River Bascule Bridge, located in Tampa, Florida, USA, was built in 1996. A significant vibration has been observed and uncomfortable noises have been reported when trucks travel over the bridge, especially during recent years. The dynamic behavior due to moving vehicles is of major concern in bridges. While considerable efforts have been made to better understand the dynamic behavior of highway bridges due to moving vehicles, most of the previous research work in this field is focused on girder and beam bridges [3 to 11]. Due to the inherit complexity of bascule bridges, few papers have been published on the dynamic loading of bascule bridges due to moving vehicles. The current American Association of State Highway and Transportation Officials (AASHTO) LRFD Movable Highway Bridge Design Specifications [1] simply increase the design live load by a factor of 1,33 for all bridge elements, except for the end floor beams with a factor of 1,66. The impact factors/dynamic loading amplification factors contained in the AASHTO LRFD Movable Highway Bridge Design Specifications are based mainly on limited test results for girder bridges. The actual dynamic behavior of

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