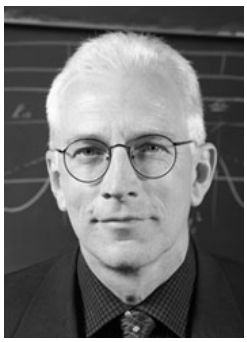
Eccentric-wing Flutter Stabilizer for Bridges

Uwe STAROSSEK
Professor, Dr.-Ing., PE
Hamburg Univ. of Techn.
Hamburg, Germany
starossek@tuhh.de



Uwe Starossek, born 1956, received his civil engineering degree from RWTH Aachen, Germany in 1982 and his doctoral degree from Stuttgart University, Germany in 1991. He has practiced for many years, mainly in the design of large bridges worldwide. He is now a consultant and professor of structural engineering at Hamburg University of Technology, Germany.

Summary

A device is presented that aims at preventing bridge flutter. It consists of wings positioned along the sides of, and fixed relative to, the bridge deck. Flutter suppression efficiency is high provided the lateral eccentricity of the wings is large. It is a passive aerodynamic device that is more economical than other passive measures or devices. Moreover, it does not contain moving parts. This is an advantage over devices with moving parts that meet resistance due to reliability concerns. Results of a numerical study are presented in which the critical wind speed for flutter onset of a bridge without wings and with wings mounted in various configurations were determined. Preliminary wind tunnel test results are reported and a cost estimate is given.

Keywords: Long-span bridge; flutter; passive aerodynamic device; fixed wing; numerical study.

1. Introduction

Flutter is a criterion governing the design of long-span bridges. Various measures have been proposed and applied to raise the flutter resistance of bridges, that is, their critical wind speed for flutter onset (flutter speed). The concept of the twin suspension bridge was described by Richardson [1] in 1981 and since implemented in a few bridges. It is a passive aerodynamic measure that takes advantage of the gap between the two (or more) bridge decks. The decks need to be connected by cross beams, which are substantial structural elements that cause significant additional costs.

An active aerodynamic device for raising the flutter speed was proposed by Ostenfeld et al. [2] in 1992. It consists of wings, installed along the sides of the bridge deck, whose pitch is controlled by actuators. A closed-loop control is envisaged in which, based on accelerometer measurements, an algorithm produces the control signals for the actuators such that the movement of the wings generate stabilizing aerodynamic forces. With such device, the safety of the bridge depends on energy supply and the proper functioning of control software and hardware – a condition that meets resistance with bridge owners and authorities. The concept has not yet been applied.

Fig 1: Passive aerodynamic-mechanical device for flutter suppression [3]

A passive aerodynamic-mechanical device was described by Starossek et al. [3] in 2008, which also includes variable-pitch wings along the sides of the bridge deck (Fig. 1). Instead of being controlled by an actuator, the pitch of a wing follows the movements of a tuned mass damper inside the bridge deck to which the wing is coupled by means of a linkage or gear. With proper tuning, the flutter suppression efficiency can be similar to that of actively controlled wings. Being a passive device, the safety of the bridge would not depend on energy supply and a control system. It still includes

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