Flutter derivatives identification on a very large scale aeroelastic deck model

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Abstract

A large scale aeroelastic model of the Third Bosporus bridge deck was designed and built to measure the aeroelastic response under different incoming flow conditions and to validate numerical models for the buffeting response of Super-long Span Bridge. The 8 m long model, with a deck chord of 1.17m, can reproduce the multi-modal dynamic response of the deck in a range of reduced velocities V*=V/(fB) between 1 and 10. The model is intended to overcome the limitations on aerodynamic similarity of traditional small scale aeroelastic models (typically 1:200 – 1:400), for validation of numerical codes to study the aeroelastic and buffeting response of long span bridges. The model allows to contemporary measure the dynamic response and the aerodynamic forces acting on the deck using 2 instrumented sections equipped with pressure taps. In the present paper, a procedure to measure the flutter derivatives coefficients of the deck, at different reduced velocities, on the large scale aeroelastic model, using forced motion tests, is presented. The research is aimed at investigating the feasibility to measure the aerodynamic properties of the deck directly on the large scale aeroelastic model presenting aeroelastic coupling among vertical and torsional modes. These results will be used in the validation procedure of numerical codes relying on the aerodynamic coefficient data set coming from the rigid model.

Keywords: wind tunnel testing; large scale aeroelastic model; steady coefficients; flutter derivatives.

1 Introduction

The fatigue design of long span bridges usually depends on the results of numerical simulations that predict the structure response to turbulent wind and traffic. The reduction of the uncertainties of these numerical models would result in a more efficient and safe design and maintenance activities with direct impact on costs and scheduling.

As far as buffeting response of long span bridges is concerned, a real estimation of the uncertainties is not easily predictable because of the complexity of the fluid-structure interaction problem and the lack of reliable benchmark data. Different research groups have proposed several numerical models for the simulation of the buffeting response of long span bridges all around the world (e.g. [1], [2], [3], [7], [8], [9], [10], [11]). The degree of complexity of these models ranges from the more simplified approaches, based on the linearization of the structural and aerodynamic terms, to the more sophisticated approaches aiming to account for the non-linear aeroelastic and structural effects.

Usually, only the simpler approaches are adopted in the design of the bridges, while the more complex ones are still a research topic for the scientific community. A common characteristic of

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