Wind Tunnel Validation of Vortex Method for Aerodynamic Coefficients

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Summary

The increasing need of knowledge about the aerodynamic behaviour of bridge decks in the early stages of the design process has been answered with the CFD technique called Vortex Particle Method. Nevertheless, any implementation of this method needs to be extensively tested, ascertain and hence validated. As contribution to the RM2006 implementation, comparisons between experimental and numerical results are made. After initial classical fluid problems and simple parametric bridge cross sections tests, three Brazilian large cable-stayed bridge projects are presented: Paulicéia, Guamá and Roberto Marinho. Results corroborate the method and the implementation, demonstrating why its use is becoming increasingly acceptable.

Keywords: wind tunnel; aerodynamics; coefficient; bridge; CFD; DVM; VPM; LAC; RM2006.

1. Introduction

This work is motivated by the increasing need of knowledge about the aerodynamic behaviour of bridge decks in the early stages of the design process. The accuracy of a simplified predictive tool will certainly accelerate the convergence to the final design. However, any numerical methodology must be extensively tested before it becomes of current use by designers. Many authors have undertaken efforts to ascertain and hence validate methods aimed at initial design. Several numerical methods have been developed, used and validated. Notwithstanding, in design offices, where the initial steps of bridge design are made, until lately, there was no really applicable tool available.

The theme's importance was predicted by Larsen [1]: "future bridges with ultra long spans,… will further accentuate the need for a thorough aerodynamic understanding even at early planning and design stages". In this context, the present work reports comparisons between boundary layer wind tunnel data of reduced models and numerical estimations by the simplified approach called Discrete Vortex Method. [2]

After a very brief overview of wind loading, bridge wind resistance design and the wind tunnel modelling, the Discrete Vortex Method and the implementation are shortly described. Initially, classical fluid problems are indicated together with the comparison of parametric cross sectional bridge shapes. Three Brazilian large cable-stayed bridge projects: Paulicéia, Guamá and Roberto Marinho are then presented as instances for analysis. Their aerodynamic coefficients were experimentally obtained at the Boundary Layer Wind Tunnel Joaquim Blessmann at Universidade Federal do Rio Grande do Sul (UFRGS). Experimental results are compared with those evaluated with the CFD module application of the commercially available bridge design software package RM2006, from TDV.

Results corroborate earlier verifications of Discrete Vortex Method, demonstrating why its use is becoming increasingly acceptable.

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