Integrated Computer Wind Design for Bridge Engineering

Johann STAMPLER
Senior Project Engineer
TDV GmbH,
Graz, Austria
office@tdv.at

Johann Stampler, born 1951, civil engineering degree from the Technical University of Civil Engineering, Graz. Over 30 years of experience in structural analysis in a wide range of applications.

Dorian JANJIC
Managing Director
TDV GmbH,
Graz, Austria
office@tdv.at

Dorian Janjic, born 1960, civil engineering degree from the Faculty of Civil Engineering, Sarajevo. 15 years of experience in technical research, software development.

Andreas DOMAINGO
CFD Engineer
TDV GmbH,
Graz, Austria
office@tdv.at

Andreas Domaingo, born 1977, PhD degree in technical physics from the Technical University of Graz 2005. Currently working as CFD engineer with TDV.

Summary

In the design process of long-span bridges the consideration of wind effects is a major point because the extraordinary slenderness of these structures yields a considerable susceptibility for wind-induced vibrations. Usually, extensive wind tunnel tests are performed to investigate the aerodynamic behaviour of such structures. Due to increasing computer power, numerical CFD methods are becoming a serious alternative at much lower costs. In the framework of the research project *NUWIMOD*, a discrete vortex method was integrated into the structural analysis program *RM2006*. This strong coupling of structural analysis and CFD calculation provides an opportunity for fast and comprehensive investigation of wind effects. In this paper, aspects of the wind analysis performed for the Hardanger fjord bridge project are presented.

Keywords: Wind impact, wind buffeting, Hardanger bridge, aerodynamic coefficients, computational fluid dynamics (CFD), discrete vortex method, wind tunnel tests.

1. Introduction

At least since the wind-induced collapse of the first Tacoma Narrows bridge in 1940 it is known that great emphasis must be put on the interaction of long span bridges and wind. Although the Navier-Stokes equations, which provide a physical model to describe the air flow, are known since the first half of the 19th century, it was not possible to solve these equations for the complicated bridge deck cross sections for a long time. The main source for aerodynamic coefficients were expensive wind tunnel tests. With the development of computers, it was for the first time possible to calculate real world problems. Since then, two major solution techniques have evolved: methods which rely on a computational grids and grid-free methods.

Grid-free methods treat the Navier-Stokes equations in a Lagrangian manner, i.e. the position of particles is tracked in time. These methods are usually termed as discrete vortex methods (DVM). First attempts to apply this method were made in the 1930s by Rosenhead. In the following the basic idea was continuously improved concerning accuracy and computation time, the last point obviously supported by the explosion of computer power in the last decade. In the 1970s and 80s, the main interest, when applying vortex methods, was to calculate the flow around airfoils. First applications of DVM methods to bridge decks were reported in the early 90s, because other CFD models so far available proved to be of too high computational effort which is a clear disadvantage in the day-to-day usage. Vortex methods were applied successfully for the calculation of many bridge decks in the last years, cf. for example [1-3]. In this sense, they can be seen as a powerful tool for accelerating the construction process of long span bridges.

The research project *NUWIMOD* aims at the integration of a DVM method into *TDV*s structural analysis program *RM2006* and the application to long span bridges like the Hardanger bridge. The advantage of such an integrated approach is that no complicated import and export of the structure geometry and resulting data between the CFD and structural analysis parts are necessary. Any change in any part is immediately accessible for the other one without further complications. This is

https://doi.org/10.2749/weimar.2007.0604

DOI: 10.2749/weimar.2007.0604