Effect of skew wind on curved long-span floating bridges

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Abstract

Long-span floating bridges have a transverse flexibility that give long natural periods. The horizontal profile is typically arch shaped to provide lateral stiffness which makes the skew wind angle (incident angle in the horizontal plane) a function of the position along the bridge. Hence, skew wind effects may be important. In this paper, a wind load module is developed for *OrcaFlex* based on classical buffeting theory extended to account for variations of the aerodynamic coefficients with variation of the skew wind angle relative to the bridge. Using this load module, the response of a 3 km floating bridge is investigated with and without skew wind effects.

Keywords: Floating bridge, Wind, OrcaFlex, CFD, Aerodynamics, Hydrodynamics

1 Introduction

A large number of floating bridges are currently in the planning stage worldwide. Long-span floating bridges are exposed to a range of static and dynamic loads, for which wave and wind loading are dominant effects. Due to their large lateral flexibility compared to bottom-founded bridges the floating bridges exhibit dynamic response for eigenmodes with periods from less than a second to well above one minute. Waves typically excite eigenmodes within a period range of 2-20 seconds. Wind is the dominating contributor above this range and may excite eigenmodes with periods up to several minutes.

Most of the existing buffeting analysis methods are based on the aerodynamic strip theory and the quasi-steady linear theory, e.g. as those developed by Davenport [1, 2], Scanlan [3] and Lin and Yang [4, 5]. These methods have been continuously refined by researchers as a result of the enhancement of computer technique and capacity as well as the demand for more accurate prediction of buffeting response of modern long-span bridges. Nowadays, not only the effects of multi-modes, inter-mode coupling, and aerodynamic coupling but also the interaction between major bridge components can be included in either the time domain [5, 6] or the frequency domain [7, 8]. However, most of the previous investigations take incident mean wind at a right angle to the longitudinal axis of the bridge.

Some researchers have thus started to look into the effect of skew wind angles on the buffeting response and on the stability criteria [9, 10, 11, 12, 13, 14]. All this work has been focused on straight bridges where the effect of the skew angle is motivated on rotating wind as in typhoons or reduced stability due to skew angles.

For long-span floating bridges the effect of skew wind angles is much more vital as floating bridges often utilize the arch effect to obtain lateral stiffness. Hence, the skew angle of wind loading (incident angle in the horizontal plane) will