Aerodynamic Flutter Control of Parallel Cable-Stayed Bridges

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Summary

When the main girders of two parallel bridges which locate in tandem are very close, the aerodynamic interference effect between these two girders may have complicated influence on the aerodynamic performance of both windward and leeward bridges. In some situations it will cause considerably loss in aeroelastic stability. In this paper, the aerodynamic performance of two parallel long-span cable-stayed bridges with Π Shaped sections was investigated based on a series of wind tunnel tests. Since the flutter performance of the parallel bridges cannot meet the requirement, a comprehensive evaluation and comparison of different aerodynamic flutter control measures, including wind fairing, vertical stabilizing plate, horizontal splitting plate and so on, were conducted. Based on these results, the aerodynamic optimization of the bridge girders was carried out and valuable conclusions were finally reached.

Keywords: Parallel bridges; Π Shaped sections; Flutter stability; Flutter control measures; Aerodynamic interference effect.

1. Introduction

There are generally two types of situation where parallel bridges are required in road and railway, one is that a new bridge is planned and built by the side of an existing bridge due to the demand of multiple vehicle lanes, for example, the Tacoma Narrows New Bridge was built in 2007 while the old bridge was restored in 1950, Whereas the other is that two new bridges are simultaneously planed based on the comprehensive consideration of traffic information, aerodynamic effects and other characteristics of structural mechanics. These famous bridges include the Fred Hartman cabled-stayed bridge in America and Foshan Pingsheng bridge in China[1-2]. With the increasing demand of traffic volume in recent years, long-span parallel bridges have been widely adopted in China, like the waterway bridge of Qingdao Bay bridge and Ningbo Yongjiang highway bridge in 2011.

When the main girders of two parallel bridges which locate in tandem are very close, the aerodynamic interference effect between these two girders may have complicated influence on the aerodynamic performance of both windward and leeward bridges, since the existence of the gap between them will make the vortex shedding process and its interaction with the movement of bridge girders more comprehensive. Many scholars paid more attention to the relationship between gap ratio D/B (D is the gap width between two bridges, B is the deck width of a single bridge) and flutter critical wind speed, and they found that the gap ratio is an important factor for the aerodynamic interference which could cause considerably loss in aeroelastic stability of two parallel bridges[1-5]. When these bridges are predicted to have unfavourable intrinsic limits in the aspect of flutter instability, it is necessary to improve the flutter performance of closely located parallel bridges by some passive aerodynamic control measures considering the interference effect. Since main girders with Π Shaped sections are widely used in cable-supported bridges with disadvantages of poor aerodynamic performance compared with streamline closed box decks, the aerodynamic

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