Influence of wind barrier on wind-resistant performance on some cable-stayed bridges in China through wind tunnel tests

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Summary

Aimming at some cable-stayed bridges in China with wind barrier erection on their girders or not, their wind-resistant performaces, such as flutter stability, vortex-induced vibration stability and aerostatic force coefficient, are investigated by wind tunnel tests considering the influence of wind barrier. The conclusions are different from some comprehension before and the new findings are useful for the cable-stayed bridge constructed in strong wind prone area adopting wind barrier to improve the driving safety of passing vehicles in windy.

Keywords: wind barrier, cable-stayed bridge, flutter stability, vortex-induce vibration stability, aerostatic force coefficient

1. Introduction

The effect of strong wind on vehicle handling and controllability on trans-oceanic bridges is vital for traffic safety, which may cause traffic stoppage, transportation time delay, economic loss, injury and even loss of life. Wind barrier might be necessary for bridges at certain locations to protect light traffic from strong cross-winds. The penalty paid for low porosity wind barrier is a very high drag loading which may amout to twice that of the deck itself(Ostenfeld et. al. 1992). Wind barrier of porosity 0,4-0,5 are more suitable for bridge design, because they offer a reasonable compromise between shelter efficiency(reduction in onset wind speed) in the range of 50%-75%, and the drag loading will equal that of a vell designed box girder. Wind tunnel tests have shown that wind barrier of 0,5 porosity can be arranged on “streamlined” box girders with little if any penalty to the aerodynamic stability (Ostenfeld 1989).

Based on above reasons, some researches about wind barrier erection on some cable-stayed bridges in China are especially investigated, and the influence of wind barrier on wind-resistant performance of these bridges is an important aspect of the wind-resistant design. The research objects mentioned in this paper namely are Hangzhou Bay Bridge opened to traffic, Hong Kong-Zhuhai-Macau Bridge and the Second Daxie Bridge under construction. Study on the aerostatic forces on the deck, flutter stability and vortex-induced vibration stability of these bridges are all carried out through wind tunnel testing. First, the rule of aerostatic forces on the decks with different types of wind barriers or not is obtained using base balance technique in a boundary layer wind tunnel. Second, wind tunnel testing data by direct flutter method shows that the wind barrier should be useful for enhancing the critical flutter speed of some cable-stayed bridge with some shape of girder, which is something contrary to the general understanding. For vortex-induced vibration of section model wind tunnel testing, wind barrier is good to improving the vortex-induced vibration stability of the bridge with some type of girder. Some long span bridges under construction in strong wind prone area in China are all in requisition for wind barrier to enhance driving safety in strong wind, therefore the conclusions about wind-resistant performance on cable-stayed bridges influenced by wind barrier will push wind barrier to be adopted in practice.

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