Wind Induced Vibration Performance of Suspended Double-deck Flat Box Girder Bridge

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Abstract

The paper researches the wind vibration performance of suspended double-deck streamlined bridge deck using the wind tunnel test and numerical simulation. Studies shown that for suspended double-deck bridge, due to the aerodynamic interference of the upper deck, the lower deck is driven by a vertical vibration negative damping, and the vertical vibration is significantly changed. The pressure distribution of the upper deck and the upper edge of lower deck did not change. The wind load acts on the upper edge of lower deck, and the minus attack angle was generated. With the generation, migration and shedding of large-scale vortices at the lower edge of the lower deck, the lower deck occurs the bending-torsional coupling "soft flutter". Moreover, due to the structural static coupling between the upper deck and the lower deck, the bending-torsional soft flutter at the lower deck induces the bending-torsional soft flutter of the double-deck bridge deck.

Keywords: double-deck bridge; wind vibration performance; wind tunnel test; numerical simulation; 'incentive-feedback' mechanism; flow mode; bending-torsional; soft flutter.

1 Introduction

Long-span bridges are extremely sensitive to the dynamic effects of wind loads, and the wind easily induces bridge vibration. Among the various wind-induced vibrations, the flutter of the bridge span structure will cause the overall damage of the bridge structure. Therefore, in the field of bridge wind resistance, the research on the flutter performance of long-span bridges is always at the core.

In long-span bridges, the structural forms of truss girder decks usually include single deck and double deck. Because the large proportion of single-deck layout, the research on the aerodynamic performance of truss girder mainly focuses on the truss girder of single-deck layout. In the study of the aerodynamic performance of the single-deck truss girder, UEDA et al [1]analyzed the flutter suppression mechanism of the central stabilizer plate based on the flow field modal through the PIV flow field display technology and pressure test. MIYATA, YAMAGUCHI [2] and XU H et al [3] studied the effect of lower central stabilizer plate and slotting on the flutter performance of truss girders through wind tunnel tests. LI JW et al [4] conducted an optimization analysis on the effect of various aerodynamic measures such as upper and lower central stabilizer plates and horizontally inclined guide vane on the flutter performance of truss girder through wind tunnel tests. WANG K et al [5] analyzed the effects of upper and lower central stabilizer plates and horizontal guide vane on the flutter performance of truss girders through section model and aeroelastic model wind tunnel tests. TANG et al [6] studied the effects of

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