Flutter stability studies of long span suspension bridge by CFD numerical simulation

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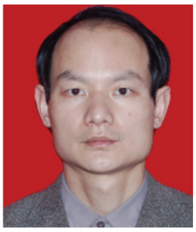

Hao Zhan, born 1971, received his Doctor's degree of bridge & tunnel engineering from Huazhong University of Science and Technology.

Summary

This paper establishes two-dimensional bending and torsion fluid-structure interaction model to calculate flutter critical wind speed of the three-tower suspension bridge.There are three main girder schemes of the bridge.Scheme 1:Sharp fairing without central stabilizer;Scheme2:Sharp fairing with central stabilizer;Scheme 3:Semi-circular fairing without central stabilizer.Numerical calculation results indicate: At +3 degree wind attack angle, Flutter critical wind speed of scheme 1 is less than flutter checking wind speed; Flutter critical wind speed of scheme 2 is greater than flutter checking wind speed. Numerical simulation results is roughly consistent with the wind tunnel test. When the wind attack angle changes,the conventional sharp fairing is easy to lead large vortex formation that causing flutter stability declined.Large vortex formation can be inhibited by semi-circular fairing as scheme 3.It meets requirement of flutter stability without central stabilizer for the bridge.

Keywords: fluid-structure interaction;flutter critical wind speed; central stabilizer;sharp fairing; semi-circular fairing; vortex motion.

1. Introduction

The three-tower suspension bridge is over Yangtze River with a span arrangement of 200m+2×850m+200m.The stiffening beam is steel concrete composite beams which is I-shaped, The center line of the beam is 2.423m high, Concrete bridge panel thickness is 20cm. The center of two pieces of steel girder distance is 31.2 m, Diaphragm plate is set along the longitudinal direction of bridge every 3m.The bridge tower is 152m high, the two main cable horizontal distance is 36m. Rendering picture of the three-tower suspension bridge is shown in Fig.1.

Fig.1: Rendering picture of three-tower suspension bridge

Flutter checking wind speed of the bridge is 47.1m/s. This paper establishes two-dimensional bending and torsion fluid-structure interaction model to calculate flutter critical wind speed of three schemes of main girder.

2. Numerical simulation

2.1 Numerical simulation principle

The structure is regarded as mass, spring and damping system.The schematic diagram of numerical simulation is shown in fig.3.The governing structural equation for the one-degree-of -freedom heaving mode and torsional mode is shown as (1) ,(2).

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