The Behavior of Long-span Suspended Footbridge Under Wind Load

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Abstract

This study examined the wind resistance characteristics of a 660 m span suspended footbridge using a wind tunnel test and numerical analysis method. The target bridge deck is a hexagonal cross-section beam supported by a three-dimensional catenary cable structure. A wind tunnel experiment was conducted to investigate the wind characteristics in the mountainous valley terrain in the simulated atmospheric boundary layer model. The wind load of the girder was applied to the numerical model considering aerodynamic coefficients and the topographical characteristics. The behavior of the girder according to the wind load was analyzed. Above a certain wind speed, the lateral and vertical displacement increased sharply, and the torsional displacement reversed from nose up direction to nose down direction. This phenomenon was due to the loss of the initial tension of the leeward cables due to the geometrical behavior of the three-dimensional cable structure. This study identifies the behavior of long-span suspended footbridges under wind loads.

Keywords: suspended footbridge; wind load; three-dimensional cable system; mountainous valley terrain; wind tunnel test; numerical analysis.

1 Introduction

Unlike general bridges, the suspended footbridges have a lightweight deck, and the stiffness of the bridge system is low. The main span to bridge width ratio is mainly used as an index to express the flexibility of cable bridges, and a long bridge span lowers the system stiffness. This makes the bridge system vulnerable to wind loads resulting necessarily a detailed review of the displacement control. Additionally, a long-span bridge located in complex terrain contains complicated flow phenomena with mean wind speed-up and variation of turbulence.

Several previous studies evaluated the response of the footbridge due to the wind loads and wind characteristics in mountainous terrain. Taylor et al. [1] and Yoshimura et al. [2] investigated the aeroelastic stability of footbridge according to different deck configurations. Tadeu et al. [3] used Computational Fluid Dynamic simulation to identify elements highly affected by static wind loads in the cross-section of the girder of the suspension footbridge. Flutter wind speed limit with different grating porosity of pedestrian bridge deck was compared by Lee et al. [4]. The wind characteristics in a mountainous valley were studied by Li et al. [5] and Song et al. [6]. Nevertheless, the nonlinear behavior characteristics of a long-span pedestrian bridge on mountainous terrain according to aerodynamic load have not been investigated, and previous relevant studies are limited in scope.

Regarding these challenges, this study focuses on the behavior of a suspended footbridge with three-

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