Influence of Time-Varying Mean Winds on the Nonlinear Buffeting Responses of a Super Long-Span Suspension Bridge

Rui Zhou, Haijun Zhou

Shenzhen University, Shenzhen, China

Yaojun Ge, Yongxin Yang

Tongji University, Shanghai, China

Contact: zhourui@szu.edu.cn

Abstract

The cosine function and two modulation functions are separately selected to generate the time-varying mean wind and fluctuating wind speed, and their effects on nonlinear buffeting responses of a super long-span suspension bridge were investigated in this paper. Firstly, two non-stationary wind speeds models were validated by the classical power spectrum density, and could effectively simulate the non-stationary characteristics. Secondly, the time histories and RMS values of three displacement responses of the bridge deck under two non-stationary wind speeds with three different values of γ and θ were compared, respectively. Results show that the torsional and lateral displacement responses under the non-uniform modulation function are larger than those under the uniform modulation function. Moreover, the RMS values in three displacement responses of the deck gradually become larger with the increase of γ or the decrease of θ.

Keywords: Super long-span suspension bridge; time-varying mean wind; uniform modulation function; non-uniform modulation function; non-stationary wind speed; buffeting responses.

1 Introduction

Super long-span suspension bridges are highly susceptible to wind loads owing to structural flexibility and low stiffness[1]. The strong typhoon disease frequently occurred in China in recent years, for example, the 16 level typhoon events of Pigeon in 2017 and Lekima in 2019. As a prominent characteristic of strong typhoon, the non-stationary wind speed has great effect on the wind-induced vibration behaviours of super long-span suspension bridges, especial for the buffeting response which could lead to the comfortability of passengers and structural fatigue damage of bridges [2-3]. In order to accurately predict the buffeting performance, it is necessary to basically study the influence of non-stationary wind on the nonlinear buffeting responses of a super long-span suspension bridge.

The non-stationary wind speed was generally divided into the time-varying mean wind speed and fluctuating wind speed. Recently, some scholars studied the influence of time-varying mean wind speed and fluctuating wind speed on buffeting performance of long-span suspension bridges. Based on the measured typhoon data, Xu et al [4] extracted the time-varying mean wind speed from

https://doi.org/10.2749/nanjing.2022.1911
Distributed by structurae