A Comparative Assessment of Aerodynamic Models for Buffeting and Flutter of Long-Span Bridges

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A Comparative Assessment of Aerodynamic Models for Buffeting and Flutter of Long-Span Bridges

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ABSTRACT
Wind-induced vibrations commonly represent the leading criterion in the design of long-span bridges. The aerodynamic forces in bridge aerodynamics are mainly based on the quasi-steady and linear unsteady theory. This paper aims to investigate different formulations of self-excited and buffeting forces in the time domain by comparing the dynamic response of a multi-span cable-stayed bridge during the critical erection condition. The bridge is selected to represent a typical reference object with a bluff concrete box girder for large river crossings. The models are viewed from a perspective of model complexity, comparing the influence of the assumptions implied in the aerodynamic models, such as aerodynamic damping and stiffness, fluid memory in the buffeting and self-excited forces, aerodynamic nonlinearity, and aerodynamic coupling on the bridge response. The selected models are studied for a wind-speed range that is typical for the construction stage for two levels of turbulence intensity. Furthermore, a simplified method for the computation of buffeting forces including the aerodynamic admittance is presented, in which rational approximation is avoided. The critical flutter velocities are also compared for the selected models under laminar flow.

1. Introduction

The life cycle of a life-line structure such as a long-span bridge is an integrative process in which each stage of the bridge's existence should be thoroughly checked, from its construction to the designed life-period. In the construction stage, the structural system of a bridge differs from in the in-service design, leading to additional