Long-term extreme buffeting response of long-span bridges considering uncertain turbulence parameters

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Abstract

Long-term extreme response analyses are recognized as the most accurate way to predict the extreme responses of marine structures excited by stochastic environmental loading. In wind engineering for long-span bridges this approach has not become the standard method to estimate the extreme responses. Instead, the design value is often estimated as the expected extreme response from a short-term storm described by an N-year return period mean wind velocity.

In this study, the long-term extreme buffeting response of a long-span bridge is investigated, and the uncertainty of the turbulent wind field is described by a probabilistic model. The results indicate that the current design practice may introduce significant uncertainty to the buffeting load effects used in design, when the variability in the turbulence parameters as well as the uncertainty of the short-term extreme response is neglected.

Keywords: Long-span bridge, Extreme response, Long-term response, Turbulence variability

1 Introduction

Developments in bridge engineering trend towards building increasingly longer bridge spans. As the bridges become slenderer, the effect of dynamic wind loads become an important load effect in the ultimate limit state design check. This is due to the wind spectrum having its largest energy at low frequencies. This development raises a need to revisit the buffeting response calculation methodology widely used in design of long-span bridges, to ensure that the safety and reliability of future long-span bridges are maintained.

Several full-scale measurement campaigns on long-span cable supported bridges has been performed in recent years [1–6]. What has been observed in many studies, is that the measured buffeting response is scattered when plotted against the mean wind velocity. Fenerci and Øiseth [6] found that the variability in the measured acceleration response of the Hardanger Bridge could be

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