Wind response sensitivities of a long suspension bridge

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Abstract

The sensitivities of wind-induced design section forces in the main girder of a suspension bridge with a span greater than 1000m are determined under variation of 20 different wind response calculation parameters. The investigated parameters cover turbulence characteristics such as length scales and correlation decay constants, as well as aerodynamic properties of the structure including both static coefficients and aerodynamic derivatives. The response calculations are performed considering both fully correlated static mean wind effects as well as low-frequent quasi-static and resonant turbulence effects. The study further comprises a detailed assessment of the convergence of stresses in the main girder as a function of number of included eigenmodes. Additionally, a full multi-modal response calculation including aeroelastic coupling effects is performed to quantify the accuracy of the simpler mode-by-mode calculation method.

Keywords: Structural dynamics, wind engineering, aerodynamics, long-span bridges, structural reliability.

1 Introduction

In this paper, the sensitivities of wind-induced section forces in the girder of a suspension bridge with a main span greater than 1000m due to variation of 20 different wind response calculation parameters are determined. The analysis is performed to support the implied safety level assessments in [1] where the wind response sensitivities are included in probabilistic reliability calculations. The mapping of these sensitivities is relevant for assessing which parameters detailed uncertainty models should be developed for.

The client and bridge names are not disclosed for confidentiality reasons. The cross-section of the main girder is a typical streamlined steel box as shown in Figure 1. In Figure 2 a plot of the global FE-model is shown, indicating the general arrangement. The approach spans are not modelled as these act as separate structures.

The investigated parameters cover wind properties including mean wind speed and turbulence characteristics including turbulence intensity, length scales and correlation decay constants.

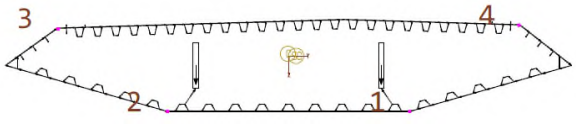

Figure 1. Main girder cross-section.

Also, aerodynamic properties of the structure are considered in terms of static coefficients and aerodynamic derivatives determined by wind tunnel tests. The response calculations are performed considering both fully correlated static mean wind effects as well as low-frequent quasi-static and resonant turbulence effects. As such, full design wind effects are presented, i.e. the shown sensitivities are relevant as reference in general design situations. The study further comprises a

https://doi.org/10.2749/ghent.2021.1675
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