Wind self-excited force models suited for floating bridges

Mitja Papinutti

Wind OnDemand, Graz, Austria

Ole Øiseth

NTNU, Trondheim, Norway

Ketil Aas-Jakobsen

Dr. Ing. A. Aas-Jakobsen AS, Oslo, Norway

Contact: mp@wind-ondemand.com

Abstract

The conceptual design of any floating bridge requires detailed investigations of its dynamic responses to achieve safe and reliable structures. Floating structures are subject to dynamic excitations due to wind or wave loads. Low structural damping is expected for long-span floating structures, and additional environmental damping is therefore much appreciated. The most important dynamic loads are wave and wind loads, where wave radiation damping, viscous drag damping, and aerodynamic damping strongly influences the overall response. Compared to hydrodynamic damping, aerodynamic damping covers a broader frequency range, stretching over multiple eigenmodes. Therefore, aerodynamic damping represents an important contribution and is the main topic of this publication. A short overview of available self-excited load models is presented. Different models are tested numerically and compared to the wind tunnel test.

Keywords: wind loads; floating bridges; self-excited; flutter derivatives; quasi-steady theory.

1 Introduction

This paper provides a short overview of available time-domain self-excited wind load models. The floating bridges are excited by wind and waves and will thus move dynamically. For most structures, linearization can be successfully applied to allow the use of linear frequency decomposition, such as linear wave radiation, linearized wind buffeting load and first-order wave loads. Some typical nonlinear response of floating bridges can be observed due to large structural displacements, viscous drag damping effects, and nonlinear aerodynamic behaviour. To correctly estimate the combined coupled and nonlinear responses, time-domain modelling is a well-suited approach. Here, the focus is on providing an overview of available self-excited models, rather than providing its global effect on different types of bridges. To that extent, various comparisons between different self-excited models will be conducted on a typical bridge deck cross-section. Aerodynamic damping contribution estimation can vary among different models, therefore numerical validation was made on a single cross-section. The wind tunnel test results are discussed on possible applications on various floating bridges.

https://doi.org/10.2749/christchurch.2021.0412
Distributed by structurae