When The Going Gets Tough The Tough Gets Going: Skyhook Structural Control of Suspended Bridge under Strong Wind Excitation

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Summary

Herein, a model of an existing suspended bridge is developed at the numerical level in ANSYS finite element code starting from original data, and it is used to simulate the structural response under strong wind excitation. The proved Skyhook control is implemented for the bridge protection and compared with other different control strategies, with due attention to their feasibility and reliability. Their efficacy is shown and the factors contributing to their positive performance are highlighted.

The control solutions here proposed are robust in the sense that they require less resources for their functioning, so that the failure of a device does not influence the efficacy of the remaining ones.

Wind loading, corresponding to the extreme event, descend from generated 3D turbulent wind fields, non-homogeneous in space to consider the atmospheric boundary layer.

Keywords: passive, semi-active, structural control, suspended bridge, wind, optimization.

1 Introduction

The world today is faced with a growing need of control of the great, and still increasing, number of large structures as suspended bridges. The modern design of complex structures must be in line with the definition and evaluation of performance, while safety must be assessed under different conditions. Structural control solutions can give an important contribution so as to satisfy the high standard of performance, feasibility and safety required.

Dynamic loading from interaction with the wind is regarded as the most aggressive external excitation for long-span flexible structures in terms of displacements and internal actions. The increased frequency of extreme events like hurricanes in many parts of the world, suggests the analysis of the response of special structures in various configurations.

In this paper a suspended bridge model is accounted as a case study for performing numerical simulations. The wind loading is considered the main dynamic excitation and it is applied on the towers, the cables and the deck of the suspended bridge. The wind load, is simulated as a spatially correlated process and acts in the horizontal direction, transversal to the deck. The wind intensity is tuned at different levels so as to investigate the bridge response with a general approach. The multipurpose ANSYS finite element (F.E.) code is used as work frame.

The attention is initially focused on passive control systems, also known as self-defence ones, which allow the dissipation of the energy without using external active power. Such control strategies require the use of properly positioned structural elements, able to absorb the energy fed into the structure by dynamic actions. Passive systems have the advantage of being generally more robust than the active ones because independent from external power sources and processed commands. They require also less operating costs and maintenance. The main disadvantage of the passive control systems is to not be able to adapt themselves to different levels of the dynamic loads.

For overcoming this last limitation semi-active control strategies are also implemented on the

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