International Doctorate in Civil and Environmental Engineering

Assessment of the nonlinear dynamic response of a long-span suspension bridge under turbulent wind

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PhD Research Project

The rapid increase in the number of long-span suspension bridges around the world emphasizes the importance of a reliable assessment of coupled buffeting response and stability of these structures against flutter. The study of the coupled buffeting response of long-span suspension bridges in turbulent flow is still an open problem. Indeed, experimental studies have shown that the aerodynamic characteristics of many innovative bridge deck designs with high aerodynamic performance are susceptible to the angle of incidence (e.g. Bocciolone et al. 1992; Zasso and Curami 1993). Nowadays, the typical procedure to address flutter and buffeting problems in the design of long-span bridges relies on the measurement in the wind tunnel of flutter derivatives (along with static force coefficients and, less often, aerodynamic admittance functions). This approach accounts for the unsteadiness of the aeroelastic load (fluid memory). However, the underlying assumption is that self-excited and buffeting forces can be linearized and, hence, in turbulent flow superposition of effects holds. The validity of this framework is controversial, and some complicated attempts were carried out to model the nonlinear aerodynamic load in an unsteady framework (Diana et al. 2008; Wu and Kareem, 2013). In contrast, to account for the nonlinearity of the aerodynamic forces on a quasi-steady basis is relatively easy, but the non-stationary effects are not considered. In this work, a new solution is found for the modelling of the wind load on suspension bridges, with the goal to take into account both, the effect of the angle of attack variation due to large scale turbulence and the non-stationarity. Once the model is set up, comparison with wind tunnel results and, hopefully, full-scale data will be carried out.

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Wu, T., & Kareem, A. (2013). A nonlinear convolution scheme to simulate bridge aerodynamics. Computers & Structures, 128, 259-271.

Curami, A., & Zasso, A. (1993). Extensive identification of bridge deck aeroelastic coefficients, average angle of attack, Reynolds number and other parameter effects. APSOWE III.