Efficient estimation of the skewness of the response of a linear oscillator under non-Gaussian loading

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Abstract

In the frequency domain, the third moment of the response of a linear oscillator subjected to a random loading is the result of the double integration of the bispectrum of the response, which corresponds to the product of the bispectrum of the loading and a second-order kernel function [1]. Both the bispectrum of the loading and the kernel are in principle complex functions.

The Multiple Timescale Spectral Analysis (MTSA) hinges on the existence of well-separated timescales in the response of the oscillator to derive simple analytical approximations of the main contributions to the integral of the bispectrum, which reduce the order of integration by one, at least [1]. The MTSA is therefore able to provide a rapid and accurate estimation of the third moment of the response. Until now, the MTSA has been applied to establish the expressions of the background and the biresonant components of the third moment of the response of a linear oscillator subjected to a buffeting wind loading, which is characterized by a low frequency content. Moreover, since the non-Gaussian buffeting loads on bridge decks are typically defined by a polynomial function of a Gaussian process, their bispectrum is actually real [2]. More generally, the real part of the bispectrum of the response is composed of the product of the real parts of the bispectrum of the loading and the second-order kernel as well as the product of the imaginary parts of these two functions. Consequently, when the bispectrum of the loading contains an imaginary part, the third moment of the response is modified by an additional biresonant component whose expression is presented and applied in this paper in the light of a statistical treatment of wind pressure data on a high rise building [3]. When the natural frequency of the system decreases, it appears that the biresonant component coming from the product of the imaginary parts becomes comparable to or even greater than the biresonant component coming from the product of the real parts.

References

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