An Evolutive Probability Transformation Method for the Dynamic Stochastic Analysis of Structures

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Abstract

The fundamental goal of a dynamic stochastic analysis of structures excited by random actions is the probabilistic determination of the structural response, once that the random properties of the actions are assigned. In the last fifty years, many significant results have been obtained in this field. Most of the approaches in the literature consider the solving input-output relations in terms of evolutive moments or cumulants. Unfortunately, all these quantities suffer the drawback of having high dimensions, above all for large systems. Only a few works perform dynamic stochastic analyses in terms of probability density function (PDF). In particular, the present authors have extended to the dynamic analysis an approach, previously introduced for static analyses and called probability transformation method (PTM) (Falsone and Settineri, 2013). This last one is essentially based on the rules of random variables transformations and on the principle of probability conservation. The above-cited extension to the dynamic analyses was made through a time discretization in the integral expression of the structural response (Falsone and Laudani, 2018). In this way, the input-output relationships are considered as algebraic equations and the PTM can be applied as in the static analyses. In the present work, an evolutive PTM (EPTM) is introduced. It combines the properties of the PTM with an approach able to find numerically the relationship between a process and its time integral by working in terms of characteristic functions, which are the Fourier transforms of the corresponding PDFs. While in the previous approach the PTM is applied after the numerical discretization, the EPTM applies the PTM contextually to the integral procedure. This makes the EPTM a very efficient approach for the dynamic stochastic analyses of structures, as has been verified in some applications that will be presented.

References

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