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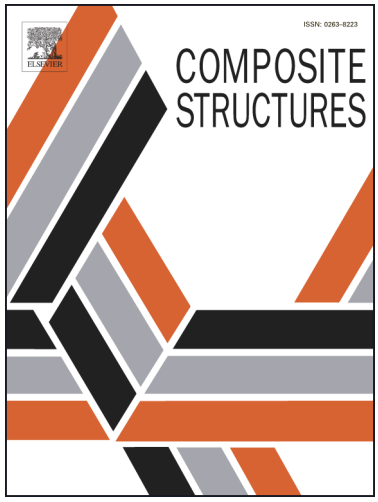


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# Performances assessment of the Modal Stability Procedure for the probabilistic free vibration analysis of laminated composite structures

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## Abstract

In this paper, the variability of natural frequencies of laminated composite structures modeled by finite elements is studied using the Modal Stability Procedure (MSP) probabilistic approach. This stochastic method is based on the modal stability assumption and associates a metamodel of natural frequencies with a fast Monte Carlo Simulation (MCS). The uncertain parameters of the structure may be material properties (elastic properties, densities) and physical properties (thicknesses and fiber orientations). A simple error indicator which is able to estimate the error level using a small number of Monte Carlo trials is proposed. Two examples are studied: an eight-layer composite square plate and a stiffened ten-layer composite rectangular plate. The statistical results obtained by the MSP and the direct MCS are compared, the latter being considered as a reference. The comparison shows that the MSP provides quite accurate results with high computational efficiency.

Key words: composite structures; probabilistic; free vibration; finite element; variability

## 1 Introduction

Nowadays composite structures are largely used in various industrial sectors. However, the manufacturing of composite structures induces a quite large variability in material and physical properties, leading to a noticeable variability of responses. In order to illustrate this variability, eight theoretically identical composite plates, made of glass and polyester, were fabricated using an infusion process. Then free vibration experiments were realized with a laser scanning vibrometer, as shown in Fig. 1.

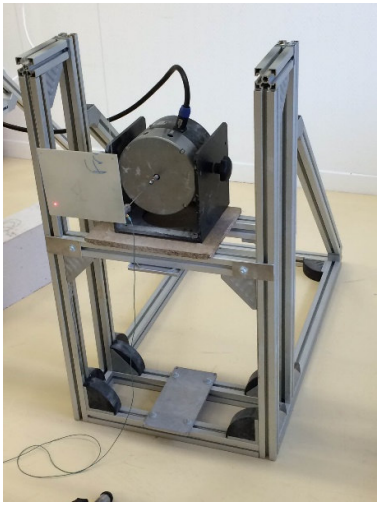

Fig. 1. Experiment equipment to measure the vibration behavior of composite plates

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