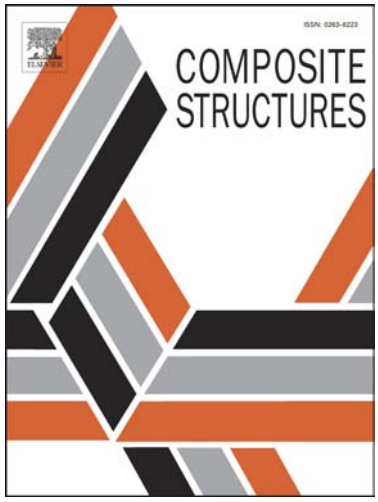

Linear statics and free vibration sensitivity analysis of the composite sandwich plates based on a layerwise/solid- lement method

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Linear statics and free vibration sensitivity analysis of the composite sandwich plates based on a layerwise/solid-element method ☆

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Abstract

Although many researches have been attracted to optimization problems of composite sandwich structures, there are rarely special literatures for sensitivity analysis which provides essential gradient information for the optimization. In this paper the linear statics and free vibration sensitivity analysis problems of the composite sandwich plates are studied based on a layerwise/solid-element method (LW/SE) which was developed in our previous work to eliminate or decrease the error induced by the equivalent methods of the core. In the present sensitivity analysis schemes the cores of the sandwich plates are discretized by three models, namely, full model, local model and equivalent model.
In the numerical examples, two kinds of sensitivity analysis schemes, the overall finite difference method (OFD) and the semi-analytical method (SAM), are employed to calculate the sensitivity coefficients of displacements, stresses and natural frequencies. The convergence is studied together with the effect of step size on the relative error. The performance of these three methods of modeling the honeycomb in computing displacements and natural frequencies sensitivity coefficients is investigated. At last, the influences of the parameters on the displacements, stresses and natural frequencies are investigated by using the sensitivity analysis scheme based on the local model and SAM.
Keywords: Sensitivity analysis; Composite sandwich plates; Layerwise theory; Overall finite difference methods (OFD); Semi-analytical method (SAM)

1 Introduction

Sensitivity analysis of structures is a usual approach to obtain the gradient information of the response quantities with respect to the interest design parameters which include intrinsic variables like material properties and thickness, as well as geometric control variables governing the size and shape of the structures. In the past three decades, the sensitivity analysis has evolved as a major research area in structural analysis, holding out immense prospect for widespread applications, for instance, structural optimization, evaluation of structural reliability, and parameter identification. Composite sandwich structures are broadly used in many engineering because they offer a high bending stiffness with the minimum mass, the capability to be tailored, the high damping properties and the great potential for impact protection. Therefore, optimization design of this kind of structures is very important. Although many researchers have been attracted to this branch [1, 2, 3, 4], there are rarely investigations for the sensitivity analysis which specially provides the essential gradient information for the optimization.

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