Material constants identification for structural health assessment of composite structures

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Abstract

Composite structures have found wide applications in the industries such as aerospace, automotive, marine, sports, wind power etc. In general, the composite structures are operated in severe environments which can induce progressive material degradations in the structures. The consequence of the material degradation is the reduction of the material constants which, when reaching a specific limit, may lead to the failure of the structure. Therefore, for structural health monitoring of a composite structure, it is important to identify the current material constants of the structure. The measured mechanical behavior of a composite structure can be used to identify the material constants of the constituent material via an inverse engineering approach. For achieving a meaningful identification of the material constants, it is essential to have efficient and effective methods for the identification. In this paper, a multi-level optimization method constructed on the basis of the sensitivity analysis the mechanical behavior of a composite structure is presented. The proposed material constants identification method can be used for quality control of composite materials or structural health assessment of existing composite structures. For illustration, the material constants identification of aged composite plate structures with different boundary conditions using the measured natural frequencies is performed. The results have shown the proposed method can identify all the material constants in in accurate and efficient way. Regarding practical applications, the identified material constants can be used to assess the structural health or predict the residue life of the composite structure.

Keywords: Composite materials, composite structure, material constants identification, aging, inverse problem, optimization

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