GLOBAL/LOCAL SENSITIVITY ANALYSIS AND DESIGN OPTIMIZATION OF AEROSPACE COMPOSITE LAMINATES

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ABSTRACT

Composite structures are known to have high stiffness-to-weight and strength-to-weight ratios, which make them good candidates for advanced applications and substantial weight saving. In contrast, it is undoubtedly clear that the design of composite structures adds new degrees of freedom (design variables and parameters) that were unavailable and, hence, unexplored in the case of metallic components [1]. One of the main challenging aspects is the relatively high computational cost associated to the optimum design of these structures. Thus, equivalent-single-layer structural theories, invariants and lamination parameters are generally used in modern practise along with gradient-based algorithms for the optimization and the sensitivity analysis of composite laminates. This approach, however, severely shrinks the design space and limits the advantages of this class of materials.

This work introduces a new methodology based on multilayer perceptrons artificial neural networks (ANNs) for the sensitivity analysis and the design optimization of composite structures [2]. A back-propagation algorithm is utilized along with Monte Carlo simulations and advanced structural theories for training ANNs to replicate response surfaces and sensitive derivatives of laminated structures versus design parameters (lamination angles, layer thickness, etc.). Dataset and ANN training process is carried out by means of Carrera Unified Formulation (CUF), according to which refined structural theories with layer-wise capabilities can be implemented in a hierarchical and unified manner [3]. Thanks to the scalable nature of CUF, the entire environment is implemented into a global/local analysis framework, which makes it possible to optimize local (critical) regions of complex aerospace structural assemblies of which finite element models from commercial software tools are available.

REFERENCES

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